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THE
LARYNGOSCOPE.

VOL. XLIV JANUARY, 1934. No. 1

A BRIEF HISTORY OF THE EARLY DEVELOPMENT OF THE ANATOMY OF THE EAR.*†

DOROTHY WOLFF, PH.D.,‡ St. Louis.

Early anatomists who investigated the temporal bone command profound respect. The obscure location and the density of the parts surrounding this important organ present serious problems to modern anatomists who have at hand numerous technical aids for scientific investigation. Surprisingly accurate were the observations of those men who possessed so little in the way of instrumental artifices for the preparation and examination of their material. In spite of limitations certain anatomic observations recorded in the middle of the sixteenth century have proven to be a closer approximation to the truth than some recorded as late as in the middle of the nineteenth century. Consider, for example, the engraving of the three ossicles with the attached tensor tympani muscle, which appears and reappears, as if for emphasis, throughout the pages of Eustachius' "Tabulae Anatomicae" (Fig. 1). We are grateful to the editor Albinus for allowing the neat design to remain here, although the association with the picture of the

‡The author wishes to present acknowledgments to Doctor R. J. Terry, to whom she is indebted for an introduction to most of the rare volumes here cited. Appreciation is also expressed to E. J. Trame, S.J.M.A., and to G. Ryan for generous assistance in rendering the Latin texts.

*From the Oscar Johnson Institute, Washington University Medical School,

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kidney seems a bit irrelevant. Lancisi does not include this plate in his edition. Contrast the accuracy of this illustration with the statement (though somewhat guarded), that a second muscle is attached to the malleus, in "The Physiological

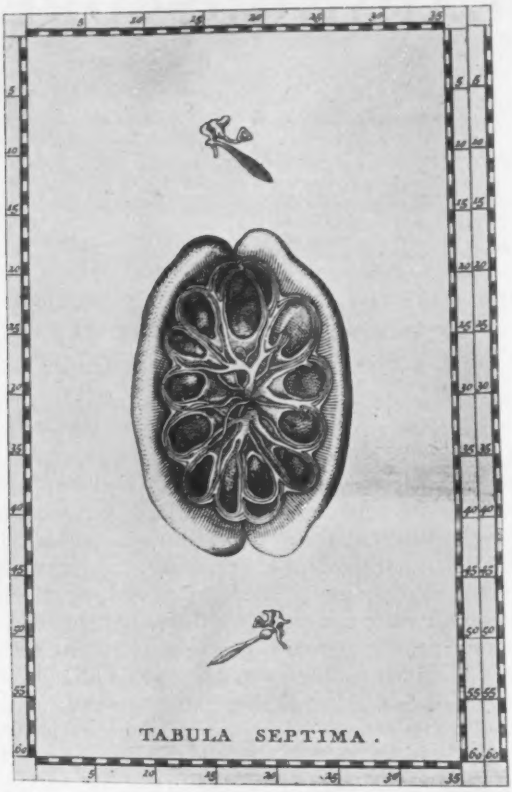

Fig. 1. Eustachius' Tabulae Anatomicae, p. 49. Bernardi Siegfriedi Albini Explicatio Tabularum Anatomicarum Bartholomaei Eustachii, CICICCCLXI.

Anatomy and Physiology of Man," Todd and Bowman (1857): "The bones (ossicles) are moved by small muscles, two of which are not disputed. . . . An anterior muscle of the malleus, or *laxator tympani* muscle, is described by many anatomists as passing from the Glaserian fissure to the processus gracilis."

In 1806, Saunders wrote of the ear, "but a structure so minute and intricate as this must forever elude perfect investigation." (On the Anatomy and Diseases of the Ear, London.)

An effort has been made to tap original sources wherever possible in compiling the following historical resumé. Only thus may we hope to gain some insight into the spirit and attitude of mind of the early students of this "elusive" subject.

From the Ebers Papyrus, a document dating about 1550 B.C., according to the translation of H. Joachim (1890, p. 181), we learn that there are four vessels to the two ears, two to the right and two to the left. The breath of life goes into the right ear and the breath of death goes into the left. (This statement very probably is the source of Alcmaeon's belief, mentioned later.) According to the papyrus, "When a patient hears by opening his mouth this shows that all his limbs are benumbed according as confusion has seized his heart." This is primarily a book of remedies, not an anatomy. Methods are given for treating running ears and those hard of hearing.

The Syriac Book of Medicine is one of the oldest books of its kind. Budge, the translator, states that there was nothing that showed where, when, or by whom it was written. He estimated its date to be in the twelfth century B.C. The seventh chapter of volume two of the translation is devoted to diseases of the ear. It is interesting to note that parallel chapters on the eye, tongue, etc., are introduced by topics such as "On the Composition and Setting of the Eyes," "On the Composition and Construction of the Tongue." The seventh chapter, however, has no such preliminary information. The introductory sentence does state that the ear is supplied by the fourth nerve. A somewhat ambiguous statement indicates the author's effort to discover analogous structures with those of the eyes: "For as there is in the eyes the crystalline fluid, so also is there in the ears that internal limit in the tubes of hearing where they touch those nerves which come from the brain." (The Syriac Book, Budge's Translation (1913), p. 110.)

According to Politzer (op. cit., p. 8), the early Hindus in Sarirast' hana (Somatology) present the following observa-

tions; in the description of bones it is stated that in its bony cavity the ear possesses a delicate nature, whose parts are in communication; there are two ear muscles and ten ear vessels mentioned which partly conduct sound; nerves are also mentioned which have to do with the perception of sound.

Contributions to Otology by the early Greeks are best represented by those of Alcmaeon (———, 500 B.C.), Empedocles (490-430 B.C.) and Diogenes of Appolonia (460 B.C.). Ball (Andreas Vesalius, the Reformer of Anatomy, 1910) states that the cochlea of the ear was named by Empedocles. The Greeks recognized the presence of the auditory (Eustachian) tube and believed the cavity of the ear was filled with air. Works attributed to Hippocrates (460-377 B.C.) are now believed to represent a compilation of the medical practices of his times rather than the activities of any one man. In the translation of the collected works of Hippocrates by Francis Adams (1886), we find that references to pure anatomy are very few. The subject, "On Injuries of the Head," is introduced by a rather vague discussion of the sutures of the skull. The only reference to the temporal bone is as follows (p. 372): "Of other portions the weakest is about the temples, for it is the conjunction of the lower jaw with the cranium, and there is motion up and down as at a joint; and the organ of hearing is near it." A discussion of treatment of the ear in cases of fractures occurs, in which the author apparently advises myringotomy. Politzer (*op. cit.*, p. 14) attributes to Hippocrates the recognition of the importance of the drum membrane, and says he considered it to be like a delicate web, also that he knew the ear bone contained many holes. But the contributions of this period appear to have been of greater import to surgery and clinical medicine than to anatomy.

Aristotle (384-322 B.C.) presents his material on the subject of the ear in the "Historia Anamalium," Book I (translated by D. W. Thompson, edited by Smith and Ross). He writes:

"Furthermore, there is a portion of the head whereby an animal hears, a part incapable of breathing. I say incapable of breathing, for Alcmaeon is mistaken when he says that goats inspire through their ears (see page 4). Of the ear, one part is unnamed, the other part is called the lobe, and it

is entirely composed of gristle and flesh. The ear is constructed internally like a trumpet-shell and the innermost bone is like the ear itself* and into it at the end, the sound makes its way, as into the bottom of a jar. This receptacle does not communicate by any passage with the brain, but does so with the palate, and a vein extends from the brain towards it. The eyes are also connected with the brain and each of them lies at the end of a little vein. Of animals possessed of ears, man is the only one that cannot move this organ. Of creatures possessed of hearing, some have ears whilst others have none, but merely have the passage for ears visible, as, for example, feathered animals or animals with coated or horny tassilates."

"Viviparous animals, with the exception of the seal, the dolphin, and those others which after a similar fashion to these are Cetaceans, are all provided with ears; for, by the way, the shark-kind are also viviparous. Now the seal has the passage visible whereby it hears; but the dolphin can hear, but has no passage visible. But man alone is unable to move his ears and all other animals can move them. And the ears lie with man on the same horizontal plane with the eyes, and not on a plane above them, as is the case with some quadrupeds. Of ears, some are fine, some are coarser, and some are medium texture; the last kind are best for hearing, but they serve in no way to indicate character. Some ears are large, some small, some medium-sized; again, some stand out far, some lie in close and tight, and some take up a medium position; of these such as are of medium size and of medium position are indications of the best disposition, while the large and outstanding ones are indicative of a tendency to irrelevant talk or chattering."

As Greek culture and learning spread to the colonies it carried with it a daring pioneer spirit. Evidence of this is seen in the Alexandrian University. When in its prime, this institution offered opportunity for human dissection (forbidden in Athens), vivisection even being performed upon criminals. Though excellent observations were made at that time on the eye and brain, apparently no contribution was made to the anatomy of the ear.

It is to Galen (131 B.C.-201 A.D.), (Siebenmann-Bardeleben's Handbuch der Anatomie des Menschen, 1905, s. 297),

*This might be translated: "The innermost bony part is also trumpet-shaped or spirally coiled, like the outer ear."

(Politzer op cit., p. 27) that we owe the accurately descriptive term "labyrinth." Galen followed the course of the facial nerve and made a study of facial paralysis. He described the mastoid process and the zygomatic. To the drum membrane he ascribed but little importance.

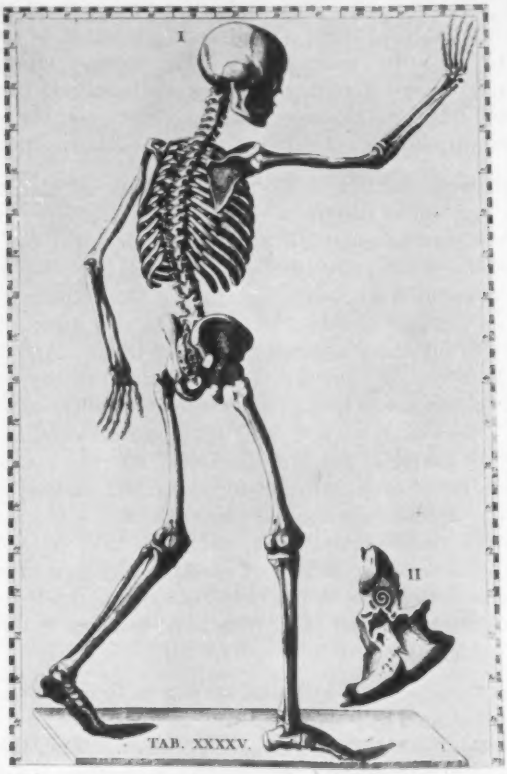

Fig. 2. Skeleton and Temporal Bone by Eustachius. Bernardi Siegfriedi Albini Explicatio Tabularum Anatomicarum Bartholomaei Eustachii, CICICCCLXI.

Aetius of the sixth century A.D. is said by Garrison (1917) to give the best ancient account of the eye, ear, nose, throat and teeth. His work on the ear follows Galen's Anatomy, but he adds the description of the interesting pathological feature, ear polyps. Incidentally he is said to have practiced tonsillectomy.

The spirit of the Mediaeval Period was, of course, productive of little in otologic anatomy. Mundinus (1275-1325?), that most modern of early surgeons, quaintly remarks that more could be learned of the ear if it were boiled, only this is sinful. His "Anatomia" (first edition, 1478) is a handbook based on the autopsy reports and dissection of two females. He described the auditory nerve among other cranial nerves.

The Renaissance Period, on the other hand, is replete with names of those who contributed to the study in question. This era was auspiciously introduced by the advent of Leonardo da Vinci (1452-1519). Although Leonardo made no direct anatomical contribution to our limited field, he added greatly to the knowledge of general anatomy through his exquisite engravings of dissected muscles and other organs. His works undoubtedly offered inspiration to such men as Vesalius and Eustachius, who did contribute markedly to otology. In the Renaissance began the era of the original "wandering student." It was a period when many universities became small democracies—when the students elected their faculty and officers and had a voice in determining their course of study. It was also the time of the barber-surgeon, whose profession as demonstrator Vesalius was to overthrow. Toward the latter part of this era the magnifying glass came into use with its wealth of disclosures. These events all tended toward the production of independent investigators. Many were the contributions made to otology.

Manfredi (1462) recognized that in the ear were certain holes and membranous organs of hearing. He believed the ear was supplied by the fifth nerve.

According to A. Wilder (1901) and Ball (1910), Allesandro Achillini, Bologna (1463-1512) first described the malleus and incus. But Politzer (op. cit., pp. 73-75) considers this statement to be erroneous. Basing his argument upon the study of "Annotations Anatomicae in Mundinum," published in 1520, a volume he obtained in the Vienna library, he contends that while these ossicles were discovered in the time of Achillini, they were not discovered by him nor even by Berengarius (1470-1550), who certainly knew of them. He quotes the following excerpt from Carpi's "Isagoga," in which quite obviously the ossicles and their position are well recognized: "Et huic panniculo intra praedictam vacuitatem adia-

cent duo ossicula parva apta moveri ab aeri ibidem proximo moto, quae in suo motu se invicem percutiunt, a quibus secundum aliquos causantur omnes speties (species) soni; plus et minus secundum aerem extrinsecus motum" . . . "and adjacent to this pannicle (drum membrane) within the aforementioned cavity, lie two small ossicles, adapted for movement (to be moved) by the same proximal movement of the air which in its activity strikes them alternately, by which according to some (authors) all kinds of sound are produced, more or less intrinsically following the air."

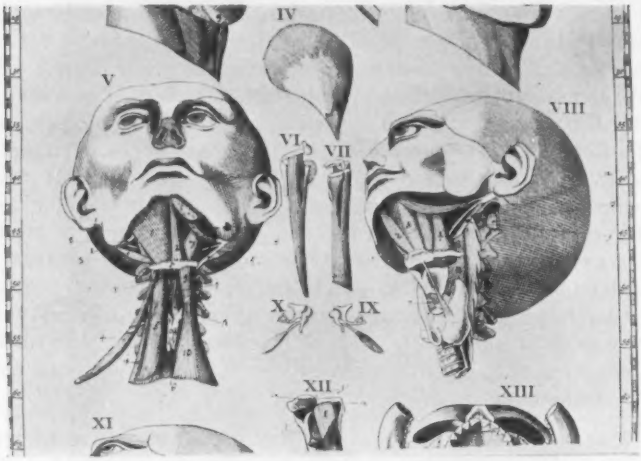

Fig. 3. Muscles of the Hyoid Bone and the Auditory Ossicles by Eustachius. Tabulae Anatomicae, Bartholomaei Eustachii Jo Maria Lancisius, Tab. XLI, MDCCXXII.

According to Siebenmann (op. cit., p. 244), Ingrassius (1510-1580) discovered the stapes and the tensor tympani muscles. This investigator also first observed the conduction of sound into the skull by way of the teeth.

Three contemporaries, all great men of their time, contributed notably to otologic investigations: Eustachius (1510-1574), Vesalius (1514-1564) and Fallopius (1523-1562). Eustachius' name has been closely linked with aural anatomy and deservedly so. Even a casual study of his engravings reveals with what interest this student examined the tem-

poral bone. At the feet of many of his animated looking skeletons (see Fig. 2), he placed a detailed drawing of the temporal bone, showing it in various aspects and sections. No other cranial bone does he treat in such detail. His illustrations show that he was familiar with the facial canal (subsequently named the Fallopian aqueduct), the oval and round windows, the carotid canal, antrum and even the endolymphatic duct. The notes and descriptions which now accompany these engravings were added a century and a half later, when the works were finally published by Lancisi and Albinus.

Eustachius was not the first to observe the tube which bears his name, but he described it accurately and realized its significance. According to Siebenmann (op. cit., p. 284), Eustachius divided the acoustic nerve into three portions. He is also credited by Turner with the discovery of the tensor tympani muscle. His drawings certainly show his familiarity with this muscle. But as noted above, Ingrassius appears to have precedence in the matter.

Vesalius, though bearing a Latinized name, as did many Teuton scholars of his time, was born in Brussels of German people. As has been noted above, he questioned the skill of the barber surgeons and the knowledge of his master, Jacobius Sylvius. By dissection not only of animals, but also of the human body, he became a reliable independent investigator and initiated the reform which led to modern anatomy. He is said to have received the equivalent of one thousand dollars per annum at the University of Pisa, where he was Professor of Anatomy (1543-1546). To him is accredited the first description of the middle ear cavity, antrum and pneumatic cells. Like Eustachius, Vesalius recorded his observations in the form of beautiful engravings (Tabulae Anatomicae, Venice, 1538; De Fabrica Humani Corporis, Basel, 1543). Since his work never suffered a period of oblivion as did that of Eustachius, Vesalius goes down in history as the first to publish illustrations of the middle ear and ossicles. The observer omitted the stapes, however, as may be seen in Figure 4. Were an artist to vote upon the relative merits of the engravings of Eustachius and Vesalius, he would probably decide in favor of those of the latter. They show a certain mellow tone not found in Eustachius' work. The mathematical precision of Eustachius' work, as shown by the scale enclosing each plate (see Figs. 1, 2 and 3), appeals to the scientist,

however. A gruesome sense of humor must be attributed to Vesalius. Most amusing indeed is his engraving of a skeleton, which, resting upon its own tombstone, contemplates the skull of another skeleton. Nearby lie the hyoid bone and two auditory ossicles. The incus is described in the text as being like a tooth and in the illustration the comparison is overdone. Myron states that Vesalius gave an imperfect account of the cochlea, which is true.

Fig. 4. Vesalius' figure of the Acoustic Nerve and Auditory Ossicles. Humani Fabrica Liber I., Cap. VII., Page 30. Cura H. Boerhaave & Bernhardi Siegfried Albini, MDCCXXV.

Since the original Latin text of Vesalius' Fabrica has not been rendered into English, so far as the present writer knows, the following section on the anatomy of the ear is introduced in the hope that it may help to extend the knowledge of Vesalius' discoveries in this field. (Humani Fabrica Liber I Cap. VIII, Opera Omnia, Vesalius, Anatomico & Chirurgica cura Herrmann Boerhaave & Siegfried Albini, MDCCXXV, p. 31:

Etiamsi in septimo libro cum reliquorum sensuum organis, auditus instrumenti fabricam simus pertractaturi, nihilominus tamen ipsa ossiculorum quorundam illam subeuntium occasione, nunc obiter venit describenda, ne forte in septimum usque librum ea ossicula prorsus asservantes, in universa alioquin ossium historia, illa praeterilsse videamur. Quanquam neque

Although we shall thoroughly treat the structure of the organ of hearing in the seventh book, together with the other sense organs, nevertheless a cursory description is advisable here because of certain small bones pertaining to it. By reserving the discussion of these small bones to the seventh book, it might appear that we had passed them over in the treatment

Galenum, neque ante illum quemvis alium haec, uti & alia sane non pauca observasse, hinc conjicitur, quod istorum nusquam inciderit mentio. Temporis itaque ossi magna admodumque varia insculpitur cavitas, quatuor a se producens foramina, quorum primum atcunque amplum, sed anfractuosum, in capitis sedem, qua cerebrum continetur, spectat, alterius lateris quinti paris nervorum cerebri nervum admittens. Secundum foramen jam dicto brevius, sed multo amplius, ad aurem pertinet. Tertium foramen augustum est, varieque implexum: & caecum, uti suo dicemus loco, appellatum, nervi quinti paris ramum transmittit. Quartum nunc dicto nonnihil amplius occurrit, & neutiquam perinde tortuosum; dein antrorsum, uti illud antrorsum, procedens, praeter alium nervi quinti paris ramum, cui iter praebet, venam transmittit, auditus organum petentem. Verum quinti paris nervus haudquaquam totus in binos illos ramos absorbetur, sed insigniori sua portione, cavitatem temporis ossi incisam, membranae quodammodo ritu succingit & oblinit: non quidem universam, sed nonnullius tantum ipsius sedes, haud secus quam si insignior nervi portio in plures diduceretur membranas, aliquot ejus cavitatis regionibus obductas. Inter caeteras autem cavitatis sedes, quarum quaedam planae sunt & laeves, quaedam vero laxioris pumicis & spongiae modo cavernosae, admodumque profecto variae, sibique dissimiles, una est orbicularis & plana, osseoque circulo lineae in modum extuberante, septa, ac demum praecipua quinti nervi portione tanquam membranula quapiam obducta.

Ad circuli hujus exteriorem, auriique proximam sedem, ossiculum reponitur, duobus tenuibus & acutis processibus, seu cruribus firmatum, adstabilitumque. horum exterius, ac auri vicinius, est brevius & crassius latiusque, ac in acutum desinit apicem. Alterum crus, quod interius consistit, & membranae orbicularem illam cavitatis sedem succingenti magis, quam exterius crus, innascitur, longius nonnihil & tenuis est, ipsiusque extremum quassi in unculum cessat, quo membranae illi implicatur, firmiusque innectitur. Ossiculi hujius pars extra

of bones in general. We surmise that neither Galen nor any other before him had observed these (not to mention quite a few other things as well) from the fact that no reference is made to them anywhere. In the temporal bone there is hollowed out a large and rather irregular cavity which gives rise to four openings. The first of these is rather spacious, tortuous in its windings and leads to the part of the head in which the cerebrum is contained; it gives entrance to the second member of the fifth pair of cranial nerves. The second so-called opening (foramen) is shorter but much wider and extends to the ear. The third is narrow and rather involved; it is called blind, as we shall note in its proper place, and transmits a nerve branch of the fifth pair. The fourth appears somewhat more spacious, with no pronounced winding, and proceeds anteriorly, just as the former; in addition to a second nerve branch of the fifth pair, to which it affords access, it transmits a vein which goes to the organ of hearing. The nerve of the fifth pair, however, is not entirely taken up in those two branches; a rather large portion of it surrounds and covers like a membrane the cavity hollowed out of the temporal bone. The whole cavity is not covered by it, however, but only certain parts of the nerve were drawn out into many membranes and applied to certain regions in the cavity. Some areas in the cavity are flat and smooth; some are like soft pumice and a sponge full of holes of varying size and no two alike. One of these cavities is whorled and flat, surrounded by a bony ring in the manner of a line swelling from it, and covered by the main part of the fifth nerve as though by a sort of little membrane.

On the outside of this circle at a point close to the ear is a small bone secured by two slender and sharp processes, or made firm by limbs (crura). The outer member nearer the ear is shorter, heavier and wider, and ends in a sharp point. The other limb, which is the inner support, is fastened upon the membrane surrounding the whorled part of the cavity more firmly than the outer limb; it is

membranam prominens, superius partim plana, partim rotunda cernitur: quemadmodum minores nonnulli incudes effingi solent, quorum amplior pars plana est: altera quae veluti in mucronem desinit, instar coni rotunda. Grandiores enim incudes penitus plani depressive & quadranguli siunt. Caeterum si hoc ossiculum quia tantum binis donatur cruribus, incudi assimilare minus placuerit, nihil profecto obstiterit, molari denti duabus tantum radicibus praedito id conferre.

Alterum ossiculum, a jam commemorato plurimum variat, alterique innascitur membranae. Foramen enim cavitatis, seu antri in temporis osse incisi, quod aurem spectat, ea parte qua cavitatis, ea parte qua cavitatis amplitudini vicinum est, membranula tenuissima & prorsus pellucida in eum modum obtegitur, quo vas suo fundo obturari dicimus. Huic itaque membranulae transversim id ossiculum innascitur, itaque ipsi intus transversim insternitur, ac in tympanis fidem unam atque alteram crassiorem membranae, seu asinorum pelli, obtendi conspicimus. Ut vero ossiculum validius firmaretur, longum tenuemque habet processum, quo membranae secundum illius latitudinem innascitur. Hunc processum liceret femoris ossis parti comparare, quae ab ipsius processibus, quos rotatores vocamus, ad inferiora usque femoris capita pertinet. imo si haec inferiora capita a reliquo femore resecta finxeris, universum ossiculum femori opportune assimilabitur. Quemadmodum enim femur juxta ipsius cervicem duos adsciscit processus, sic etiam ossiculum hoc eadem sede processulos aliquot sibi vindicat, quorum beneficio membranae suae firmius innascitur. Dein, ut femoris ossis cervix oblique versus corporis interiora ad coxendicis ossis sinum vergens, in caput ad amussim rotundum cessat: ita etiam ossiculum a membrana introrsum abscedit, in rotundum caput definens, quod laeve minimeque asperum est, & superiori parti alterius ossiculi, quod molari denti, aut incudi assimilavimus, ita tenuissimarum membranarum interventu committitur, ac si malleus incudi laxe alligaretur: non fecus, quam si ossiculum postremo enarratum malleoli praestaret munus, al-

somewhat longer and thinner, and comes to an end in a kind of little hook with which it clings to the membrane and is fastened more firmly. A part of this little bone somewhat flat and round is seen extending beyond the membrane, just as some anvils are often made whose large part is flat and the rest ending in a point, as it were, is rounded like a cone. Larger anvils, however, are entirely flattened and squared. If perchance the comparison of this little bone to an anvil is not so apt, because it has but two limbs, surely nothing prevents our comparing it to a molar tooth which has but two roots. The second little bone varies considerably from the one just described and is fastened upon another membrane. For the opening of the cavity of the antrum hollowed out in the temporal bone which pertains to the ear, is covered in the part nearest the diameter of the cavity by a very delicate and almost transparent little membrane, in the manner in which we say a vase is closed by its bottom (base). This little bone is fastened obliquely upon this little membrane and stretches crosswise and inward, like a tambour with one string and another heavier stretched over the membrane or ox-hide. That the bone might be fastened more firmly, however, it has a long thin process by means of which it is fastened upon the membrane along its breadth. One may compare this process to the part of the femur which reaches from its processes called the trochanters, to the lower shaft. Indeed, if you imagined the lower shaft of the femur cut off, the entire bone will be favorably compared to the shortened femur. For just as the femur at the side of its neck has two processes, so this little bone has little processes in the same place by means of which it is fastened more firmly upon its membrane. Then just as the neck of the femur lies obliquely toward the interior of the body, at the curve of the hip-bone. and comes to a completely rounded head, so also this little bone tends inwardly from the membrane and comes to a rounded head which is smooth and not uneven, and is connected with the upper part of the other little bone, which we com-

terum vero incudis vicem gereret, sed prō mallei mole nimis quam parvi.

Num autem ossicula incudis & malleoli officio ita fungantur, atque formam referunt & levissimo affiatu secundum ossiculum cum membrana cui innascitur, inter dissecandum movetur, primo ossiculo interim quodammodo quiescente, a me haudquaquam assertum velim, quandoquidem auditus rationem non satis ex sententia percipiam. Non quod mihi animo exciderit, commune illud medicorum ad partium temperiem, ac formam demum essentialem, asylum aeris gyri, quos ex hujus percussu in aurem ferri, & quandam membranam ferire, vulgo nobis e lapillorum in aquam jactu persuademus, interim organi hujus constructionis prorsus ignari. Longe enim diviniora rerum Opifex callidissimo artificio hic machinatur, quorum fabricam satis dilucide in scholis quidem commonstro, usum autem & operandi modum non magis quam oculi ipsius assequor. Verum quia de auditus organo postea pertractabitur, hic sat sit ossicula recensuisse: quae si hoc fermone non sueris assecutus, vituli, aut agni, aut alterius animalis capite in mensam posito, temporum os nunc hoc, nunc illo modo divides. Quanquam multo fatius sit, haec in crudo capite, quam in cocto aggredi: idque in homine potius, quam alio quovis animali. Neque solum hoc administratione, spectatu jucundissimam ossiculorum constructionem adinvenies, verum insuper ommium pene musicorum instrumentorum fabricae rationem ex auditus organi compage desumplam perinde admiraberis, ac vel hoc in primis nomine, auditus organi harmoniam summa voluptate intueri solitus est, non modo musicorum absolutissimus, verum & nostrae aetatis philosophorum eximium decus Marcus Antonius Genua, cui rerum naturalium studiosi tantum debebunt, quantum frugis ex hoc meo conatu ipsis accedet: quippe qui ad hunc inchoandum primus autor, ac fedelus monitur haud minus extitit, quam rarum virtutis exemplar Wolfgangus Heruwit, patricius Augustanus, ob incredibilem erga literas earumque cultores amorem, immortalitate dignissimus, ac mihi dum vivam

pared to a molar tooth or an anvil, but an exceedingly small anvil considering the size of the hammer.

Whether, however, these little bones perform the duty of hammer and anvil just as they represent their form, and whether the second bone, with the membrane to which it is attached, is moved by a slight impact while the first bone remains somehow unmoved, I should by no means like to assert, since in my judgment, I do not sufficiently understand the method of hearing. (I say this) not because I am unaware of the common explanation of the doctors for the organization of the parts, the essential form, the enclosure and circles of air which we persuade ourselves are carried by the impact of this ossicle to the ear and beat upon some membrane (arguing) commonly from the throwing of stones into the water, meanwhile being entirely ignorant of the structure of this organ. For the Designer of things (the universe) with surpassing skill here devises something infinitely subtle, the structure of which I show with sufficient clearness in my classes, but whose use and mode of functioning I understand no more than that of the eye itself. Since the organ will be thoroughly treated later, it is sufficient here to have described the little bones; and if you have not understood these from the description, then place the head of a lamb or a calf or some other animal upon the table and divide the temporal bone, now this way, now that. It would be much more satisfactory to attempt this with a raw head rather than with a cooked one, and with a human head rather than that of any other animal. Not only will you find the most pleasing structure of bones, if examined with this direction, but moreover you will marvel that the method of construction of nearly all musical instruments has been taken from the structure of the organ of hearing; just as Marcus Antonius Genua, not only the most accomplished of musicians, but also the distinguished philosopher of our age, a man to whom the students of natural science owe a debt in proportion to the fruit they have derived from this attempt of mine;

unice colendus quod ad hujus operis absolutionem, quantum, in ipso fuit, nihil fecerit reliqui.

(he) who used to behold with the greatest pleasure the harmony of the organ of hearing; certainly he who was the first instigator of my undertaking (research) and its faithful critic is hardly worthy of less honor than that unusual example (ideal) of character, Wolfgang Heruwit, Augustan patrician, worthy of immortality because of his unbelievable love of literature and its devotees, and alone to be cherished by me as long as I live because as far as in him lay he left nothing undone for the completion of this work.

Of the many valuable contributions to anatomy made by Fallopius, his discovery of the trigeminal, the auditory and the glossopharyngeal nerves most concerns us. He saw the chorda tympani, but it is doubtful if he understood its connections. The semicircular canals were also described by him. According to Politzer (op. cit., p. 81), he made a careful study of the hearing organ of different ages. He observed that the mastoid process was absent in the newborn and gradually increases in size with the process of growth. He recognized the communication of the mastoid cells with the middle ear cavity. He gave the first accurate description of the course of the facial nerve through its canal, which was subsequently named the Fallopian canal. He studied the two windows, the promontory and the articulation of the ossicles. Siebenmann (op. cit.) states that he named the fenestra rotunda and fenestra ovalis. He believed pus in the middle ear to be an exudate from the brain, as did Hippocrates. The following quotation concerning the facial canal, copied from Politzer (op. cit., p. 92), comes originally from Fallopius' "Observationes Anatomicae," page 46:

Tertium quod ego observatione dignum existimo, canalis quidam osseus est, qui recto huius cavitatis quasi subtenditur exitque extra calvariam post radicem, calcaris inter illam ac mammillarem processum. Nam si recte inspicias, videbis quintum par nervorum a reliquis anatomicis ita vocatum, extendi ad medium ferme processum ossis temporum, quem internum atque petrosum appellamus, illuc tensum hoc par ingreditur in canalem quendam insculptam, in quo latens in duas finditur partes, alteram quendam magnam, alteram vero parvam et

The third (detail) which I deem worthy of observation is a certain bony canal which stretches, as it were, to the right of this cavity and comes outside the skull beyond the root of the styloid process, between that and the mammillary process. For if you observe it rightly you will see that the fifth pair of nerves, so called by the other anatomists, stretches almost to the middle of the temporal bone, which we call internal and petrous; stretched from this point this part enters a certain hollowed canal in which it is concealed and there it

gracilem valde durioremque. Haec posterior perforato osse occulto quodam canali, versus anteriora capitis serpit, deinda reflexa, tympanumque ingressa proprio hoc canali osseo deorsum et posteriora versus ad pinnae ipsius auriculae radicem erumpit et disseminatur ut suo loco dicam. Via igitur istius nervi canalis hic est, de quo loquor et aquaeductum a similitudine appello.

is divided into two parts, one rather large, the other, however, small, very slender and rather tough. This latter creeps (winds its way) by a hole in the bone to a certain hidden canal toward the anterior part of the head, then turns and enters the tympanum by its own bony canal and turning downward and toward the rear, emerges at the base of the wing of the ear itself and is disseminated there, as I shall explain, in its proper place. The path, therefore, of that nerve is this canal of which I am speaking and which I call the aqueduct because of its similarity.

With the approach of the seventeenth century the interest in anatomical investigation was gradually disseminating from Italy. Industrious scientific pioneers continued to seek their training in this country. Volcher Koyter (1534-1600), a native of Holland, became a student of Fallopius in Padua. His contribution consists, not of original observations, but of a compendium of the work of his time, entitled "De Auditus Instrumento." Fabricius ab Aquapendente (1537-1619), also a pupil of Fallopius, observed that the ossicles of the newborn are as large as those of the adult and that the middle ear cavity is filled with "mucous." This was undoubtedly what we now know to be mesenchyme.

Almost like a biblical genealogical chapter runs the history of each great anatomist teaching his successor. As Vesalius trained Fallopius, so Fallopius trained Fabricius. Then Giulio Casserio, prosector for Fabricius, produced in 1600 the first comparative anatomy of the ear ("De vocis auditusque organis historia anatomica," Ferrara, 1600). Most remarkable is the plate (Table XI) depicting the ossicles of the ten different animals,—man, calf, horse, dog, leporis (leopard?), cat, sheep, goose, mouse and pig (Politzer, op. cit., p. 119).

The name of Vidus Vidius (Guido Guidi), a Florentine (-1569), is of interest to anatomists of the ear because of this investigator's work on the nerve of the pterygoid canal. Aside from being the first to describe this nerve, which has been named the Vidian, there is some doubt as to the originality of any further contributions of Vidius to the anatomy of the otic region. Siebenmann (op. cit., p. 244), however, ascribes to him the discovery of the membrana tympani secun-

daria. Varolius (1543-75) is said by the same author to have discovered the stapedius muscle and Veslingius (1641) the long process of the malleus.

From Italy the center of learning was now definitely spreading north to France, and this at a time when our subject was ripe for that investigation of the delicate and the minute which has ever fascinated the French mind. Bauhin (1560-1624), although born in Switzerland, was of French parentage. He is a man justly claimed by the botanists as well as by the anatomists. In 1605 he published his "Theatrum Anatomicum" (Francoforti ad Moenum, 1605). In this he devotes seventy-eight pages and two plates to the ear. From his plates one is led to believe that he thought the petrous portion in man could be hulled out as it can in a pig. Politzer (op. cit., pp. 124-125), however, tells us that this particular figure is copied from Plater (De corporis humani structura et usu Libri III tabulis methodice explicati iconibusque acurate illustrati Basiliac, 1583). Bauhin gives no illustration of the cochlea, but on page 848 discusses at length its windows, coils and the "aer implantatus" (innate air). He illustrates the incomplete tympanic ring, and quite imperfectly, the ossicles.

Claude Perrault (1613-1688) described in "Essais de Physique, etc.," Tome III, 1680, the lamina spiralis ossea, calling it the membrana spiralis. His illustrations indicate that he must have understood it very well. He also described the nerve entering the spindle, and named the vestibule.*

Jean Mery (1645-1722) was the first to describe the synovial capsule of the ossicles and recognized the joints as partly ginglymous, partly arthrodial. He is said to have been the first to have realized that the walls of the semicircular canals could be separated from the surrounding bone and he knew that two canals entered the vestibule. He described the cochlea as having two and a half turns and knew that it was divided into two scalae which communicate at the apex.

The most important French contributor of the times was du Verney (1648-1730). The "Tractatus de Organo Auditus" occurs with the "de Aure Humana, Tractatus" of Valsalva, in a small hand-bound volume (Norimberg, 1734), the boards

*According to Cumston, Perrault attributes hearing to atmospheric vibrations which were perceived only by the spiral lamina of the cochlea.

of which are simply but neatly encased in parchment. Du Verney's concise treatise is contained in forty-eight pages, followed by sixteen accurate and exquisitely drawn plates, each with a comprehensive descriptive legend. Marginal topic headings are found on every page. The author opens the work with a preface and then divides his theme into three parts. Each part is preceded by a brief table of contents, as it were. In the first of these he states that the ear is composed of an external and an internal part. The internal part consists of a "cavitas prima" and a "cavitas secunda." The cavitas prima contains five important points to be noted: (1) Two

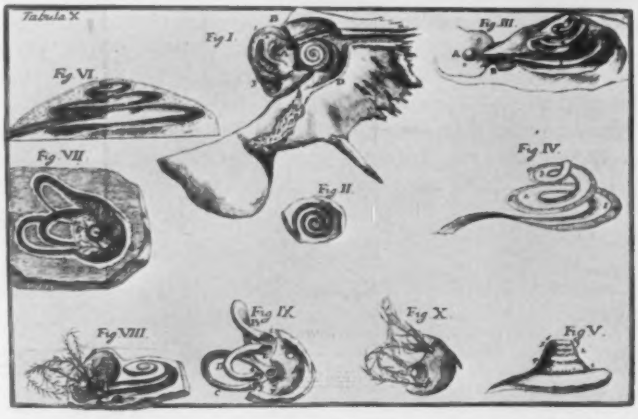

Fig. 5. Du Verney's Engraving of Parts of the Ear. From "Tractatus de Organo Auditus."

meati, one which leads to the palate, one which leads to the mastoid; (2) two windows; (3) four ossicles, malleus, incus, stapes and the last he simply refers to as "quartum." This is quite evidently the lenticular process of the stapes. It is well known that in the infant this is separate. In the adult the delicate attachment to the incus is often less durable than the incudo-stapedial joint so that it might easily be mistaken for a separate bone, especially in suppurating ears. This author also describes (4) two muscles for the malleus. The "external" one of these is now known to be the anterior ligament of the malleus, but in younger specimens and occasionally in older ones, is so extensive that it might, on gross examination,

be mistaken for at least the tendon of a muscle. This may be the source of the erroneous idea cited on page 2 from Todd and Bowman. An attempt to describe the real function of the stapedius muscle presents some difficulties to du Verney. (5) Ramus nervi.

The second cavity of the inner ear is divided into three parts, the vestibule, the semicircular canals and the cochlea, all of which are very accurately described and illustrated (see Fig. 5). In fact, the illustrations of the membranous spiral lamina are only equalled by those of Retzius or Hardesty of a later day. The author describes the subarcuate fossa. It is not surprising that he thought air, as well as fluid, was contained in the labyrinth when we realize that at this time air was still believed to be in the blood. Although physiology and a study of the theories of hearing are not the province of this paper, it seems advisable to quote some parts of the original in which the anatomy and the theory of audition are closely bound. Du Verney's ideas antedated not only those of Helmholtz, but even those of Valsalva and Cotugno. Thus this appears to be the first explanation of the Resonance Theory.

The excerpt is from page 22 of the "Tractatus de Organo Auditus," MDCLXXXIV.

Dixi dudum fenestram ovalem exacte claudi basi stapedis: Ossiculum hoc siccum & delicatum, cuius alterum latus membrana tectum & basis admodum tenuis est, ubi tremores duorum aliorum, & aeris in tympano clausi recepit, facile admodum, eos communicare potest vestibulo & aeri inibi detento postea autem cochlea & tribus canalibus semicircularibus. . . . .

I have just said that the oval window is accurately closed by the base of the stapes; this dry and delicate ossicle whose one side is covered by a membrane and whose base is quite fine, where it receives the vibrations of the two others and of air enclosed in the tympanum; it is easily able to communicate these to the vestibule and to the air retained therein; afterwards to the cochlea and the three semicircular canals. . . . .

The next excerpt comes from page 23 of the same volume.

. . . (5) Ramus notabilis portionis mollis nervi auditorii, ubi ad basin cochleae pervenit, in complures ramusculos seu filamenta dividitur, quae transeunt per meatus istos parvos, quibus basis dicta pervia est, et in diversis laminae huius spiralis gyris absorbentur. Denique & lamina haec non tantum diversos omnes aeris tremores

. . . (5) The principal branch of the soft part of the auditory nerve is divided into very many little branches or filaments where it reaches the base of the cochlea; these pass through the small holes with which the base is perforated and are absorbed in the different circles (gyri) of this spiral lamina. Finally this lamina takes up not

excipit, sed & structura eius docet respondere eam posse diversis eorundum characteribus. Cum enim latior fit, ad initium primi gyri sui, quam ad finem ultimi, ubi in acuminatam desinit figuram, adeoque caeterae eius partes ratione latitudinis paulatim diminuantur, dici potest, partes eius latiores moveri posse immotis caeteris, adeoque tremere tantum lentius, quod gravibus tonis convenit: è contrario, cum partes eiusdem angustiores impelluntur, quorum tremores citiores sunt, atque ita tonis acutis respondent, perinde ut fieri solet in chalybe in spiram contorto, cuius partes latiores tardius tremunt, & tonis gravibus respondent; partes ve o minus latae, & frequentius & velocius, adeoq: cum tonis acutis conveniunt: ita tandem secundum diversos laminae spiralis motus, spiritus nervi, in substantiam eius divisi, diversas recipiunt impressiones, quae cerebro varias tonorum figuras repraesentant.

only the different vibrations of the air, but its structure indicates that it can respond to their varied characteristics. Since it is broader at the beginning of the first circle (gyrus) than at the end of the last (circle)—(gyrus) where it terminates in a pointed design, and the remaining parts gradually diminish in diameter; it can be said that the broader parts can be moved while the rest are unmoved and so vibrate more slowly as is suitable to the lower tones. On the other hand, when the narrower parts are struck, the vibrations of which are swifter and so correspond to the higher tones, just as in the case of a trumpet curved into a spiral whose wider parts vibrate more slowly and so are suited to the lower tones, but the less wide parts vibrate more swiftly and so are suited to the higher tones, so according to the different motions of the spiral lamina, the vital elements ("spirits") of the nerve divided throughout its substance receive different impressions which represent different tone designs to the cerebrum.*

Here we have the same idea which Corti develops at a later period. Corti's statements were of course based upon microscopic observations of the interior of the cochlea and were therefore more accurate. We now believe the basal turn receives the higher tones instead of the lower. Corti's observations explain the seeming discrepancy.

Valsalva lived from 1666 to 1723. His work, "De Aure Humane Tractatus," 1707, is compiled in much the same way as that of du Verney's. It covers one hundred and twelve pages and includes nine plates. The marginal notes give not only the topic of discussion, but also include references to the anatomical descriptions and illustrations elsewhere in the treatise. In the preface he records that he used the camera optica and other optical instruments to study his many dissections. In the course of his treatise he refers to the works of Schellhammer and Casserius.

Valsalva divided the ear into three parts, exactly as is done by modern investigators. In describing the tympanic membrane he still held to the idea of the older anatomists, that

*Du Verney here seems to indicate an appreciation of the threshold value of regional sensitivity in a nerve cell.—E. T.

the membrane was derived from the dura, although he recognized that externally it was covered with cutis. He described the course of the chorda tympani. In reference to the labyrinth, he spoke of the inferior canal as the major canal, the superior as the minor and the medial (horizontal) as the minimal. He described the canalis communis (crus commune) accurately and stated that all of the semicircular

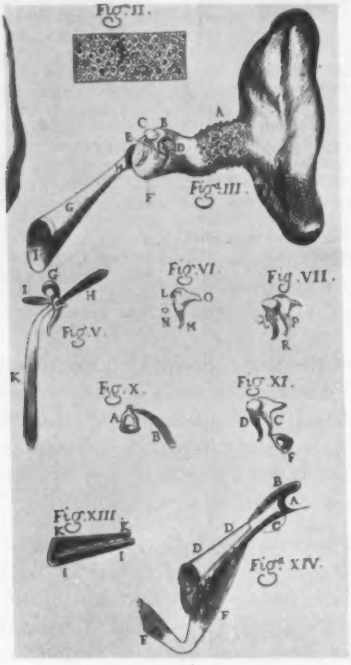

Fig. 6. De Aure Humana Tractatus -Valsalva, 1707, Tab. III. Note the inverted cartilage in Fig. XIII.

canals do not describe a cylindrical cavity, but rather an elliptical cavity. However, he observed that the minor (superior) canal did describe a cylindrical cavity and possessed double amplitude. Valsalva objected to the use of the confusing terms "scala superior" and "scala inferior" and used the terms "scala vestibuli" and "scala tympani," which have been retained in modern terminology. He believed that air

was in the labyrinth, but he also stated that in the infant it was reddened with blood. According to Gradenigo, Valsalva believed that the lamina basilaria was a septum of musical bands tense and resonating, whose larger width was at the base of the cochlea rather than at the apex and therefore higher tones would be heard at the apex. Thus we have a

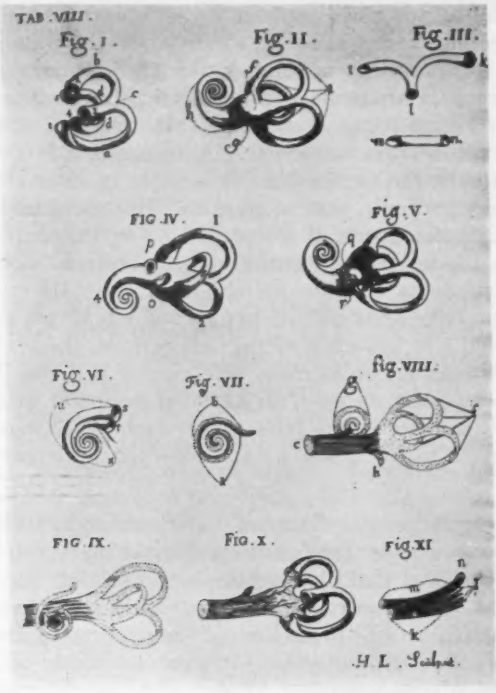

Fig. 7. De Aure Humane Tractatus, Anatonio Maria Valsalva.

further development of the resonance theory, although the localization of high tone reception, like that of du Verney's, is not that generally held at the present time.

Of especial interest is his Plate III, which gives an excellent diagram of the auditory tube, its bony and cartilaginous parts, and the "musculus tubae novus." In Fig. V of this table the author illustrates three muscles attached to the mal-

leus. In the text he calls them the muscles of the major process, of the minor process and of the minimal. His Plate IV. shows the base of the skull and the course of the auditory tube in relation to the styloid process, the pharynx and the "salpingo-staphilini muscle." Figure 7 (Tab. VIII. of Valsalva) clearly shows his excellent interpretation of the membranous labyrinth.

Hoping to find some explanation of Valsalva's depiction of the three muscles attached to the malleus, the present writer turned to the works of Cuvier. In 1845, Cuvier published his "Lecons D'Anatomie Comparés," in Paris. One hundred and thirty-nine pages of the thirteenth chapter of the third volume are devoted to the ear. Although this is a comparative anatomy, the author did not hesitate to enter the field of physiology and even that of physics. He introduced his subject with a discussion of sound and noise, the ability to distinguish the orders and quality in one and the same sound, the articulations of voice in mammals, etc. He stated that musicians have assigned the number of vibrations audible as being from 1 to 1024, but added that perhaps these vibrations are not the same for animals. He rightly believed that comparative anatomy afforded an excellent means of determining which are the essential organs of hearing because those organs would occur in all animals. He observed that fish have no cochlea.

Cuvier referred to Flourens' "Recherches experimentales sur les proprietes et les functions du syst. nerv., etc.," as he finally concluded that the cochlea is the seat of the sense of hearing, because destruction of the cochlear nerve produced deafness while the destruction of the nerves to the canals produced other phenomena. On page 481 is to be found a suggestion of the Resonance Theory and the statement of the variable length of the spiral lamina from apex to base of the cochlea. The discovery of this is generally attributed to Corti, but as has been shown above in this paper, it was known to du Verney. In describing the cochlea the author refers to the description of Fabricius and Scarpa.

Cuvier's comparative study of the subject begins with insects and includes molluscs and a review of the vertebrates. The reader feels that in places the author has become too dependent upon his sources and not dependent enough upon

personal observation. He describes for the human three muscles attached to the malleus, as did Valsalva.

Politzer says Cotugno was the first who had the courage to break the old tradition that the labyrinth contained air and not fluid. Perhaps this is not remarkable after all, for by this time Harvey had published his "Anatomical Studies on the Motion of the Heart and Blood" (1653). In this treatise the famous Englishman had emphatically stated that blood and blood alone was contained in the arteries.

This fact being established, it was not so difficult to transfer the same idea to the labyrinth. Corti tells us that Theodore Meckel (son of the famous Johann Fredrick Meckel) in 1777 proved that liquid and no air was contained in the labyrinth. According to Corti, Meckel did this by freezing fresh specimens. But since Cotugno's paper appeared in 1760, he receives priority in the matter. It seems strange that Corti, a fellow-countryman, should not have recognized this.

Gradenigo* in a stirringly patriotic article (1918) gives us a good description of Cotugno (1736-1822), the man and his contributions to Otology. The treatise, *"De acqueductibus auris humanae internae,"* appeared in 1761 when Cotugno was but twenty-five. Apparently the youth of the author was against him, for although his observations have since been found to be accurate he was unable to convince his contemporaries. He described the aqueducts of the cochlea and vestibule, and knew that small veins accompany these. He discovered the endolymphatic fluid. He believed, according to Gradenigo, that we perceive sounds in the vestibule and discern them in the cochlea. He explained the whole theory of resonance, the response of a single chord to a single tone, the localization of low and high tones, etc. He claimed that there were two circulations in the labyrinth, a greater and a lesser.

The contribution of Alphonse Corti (1851) is interesting and important for many reasons. He presents in "Recherches sur l'organe de l'ouie des mammiferes" the first detailed description of the sensory end-organ of hearing. The article is written in French, by a Sardinian who was working under a German professor. Due credit is given to contemporary investigators—Huschke, Hyrtl, Breschet, Kölliker, Bowman

*The author is indebted to Joseph Domenic Cierri, M.D., for translations from the Italian.

and Todd. The work is based upon microscopic observations of very fresh material taken from the cochlea of ten hundred or more common animals and man. The reagents used were nitric acid, chromic acid, sublimate, ether, alcohol and even a simple sugar solution was employed when studying the blood vessels. The treatise covers sixty pages and includes two colored plates of the organ which now bears Corti's name. The drawings are not at all realistic, but are rather like the technical mechanical drawings of an architect (see Fig. 7).

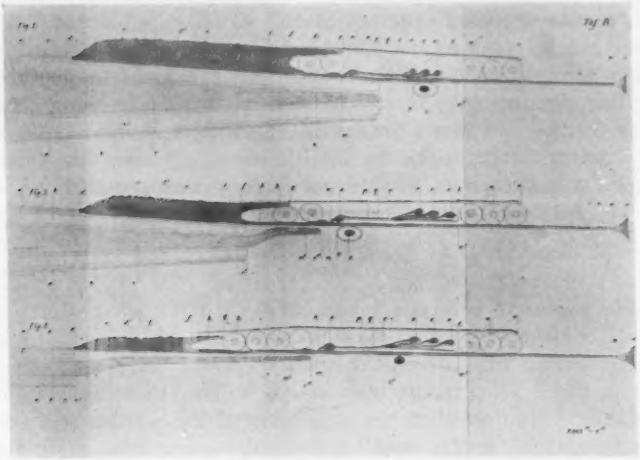

Fig. 8. Recherches sur l'organe de l'ouie des mammiferes. Par Le Marquis Alphonse Corti Taf. IV. Zeitschr. f. Wissenchl. Zool. III, 1851.

Another interesting feature of the paper is the fact that the subtended notes are more voluminous than the main body of the paper. For the modern investigator these notes contain more meat than the main paper.

Accurate measurements of the membranous and bony spiral lamina are given. The observation, made for the first time by du Verney (although apparently unknown to Corti), that the bony spiral lamina in the basal turn is broader than in the apical turn, was further established by Corti's observation that the membranous spiral lamina in the basal turn is shorter than in the apical. (This is a most significant observation when related to the fact that low tones are received in the

apical turn and high tones in the basal turn of the cochlea.) The author divided the organ into the pectinate zone and the dentate zone. He observed the pillar cells and the different ranks of "toothed cells," now known as "hair cells," also the tectorium. In addition to features in the actual end-organs, he observed pigment cells and considered them to indicate a pathological storing of hematin, although he admitted their similarity to the pigment in the eye. He noted that the perivascular spaces were three times larger than the cochlear vessels in them. He refuted Kölliker's idea that there was a muscularis cochlearis. In spite of this, Todd and Bowman, writing in 1857, devoted a complete page of fine type to a description of the "cochlear muscle," a feature now established as the spiral ligament.

Corti had intended to continue investigations in the realm of anatomy, physiology and chemistry of the organ. The article just cited is the only one which has come to the attention of the present writer. It is very probable that the activities of this investigator were cut short by arthritis deformans. According to J. Schaffer (1914), Corti was forced by advancing disease to retire to his estates. In spite of his handicap he continued to contribute to the welfare of his community by directing his vineyard with such skill that it became the model for Sardinia. He also established a school for the training of vinegrowers. Such was the spirit of the man whose assiduity has linked his name with the important anatomic feature of the organ of hearing. How great the loss to science because of his inability to continue his investigations can never be estimated.

From this time to the present the number of important investigators of the anatomy of the ear multiplied rapidly. Driven, perhaps by necessity, many famous clinicians took the lead in making important contributions. The forerunner of these was Scarpa (1747-1832). According to Retzius (Das Gehörorgan der Wirbeltiere, 1881), Scarpa first described the existence of a similar membranous labyrinth in numerous forms, from fish to higher vertebrates. He described the two membranous vesicles in the vestibule and the spiral course of the cochlear nerve as it proceeds through the sieve-like modiolus. Routine examination of autopsy material was apparently inaugurated by Toynbee in 1852 and '53. He gives

the case histories, the findings (primarily by gross examination) and the methods for procuring the temporal bones at autopsy. Von Troeltsch, writing in 1858, calls attention to the excellent collection of specimens in London and to the necessity for the Germans to report routine cases rather than malformations alone. Voltolini, in 1860, reported five cases with histories and a description of microscopic findings based on serial sections. These men were the pioneers in the work which Dr. S. J. Crowe (Johns Hopkins Medical School) has established in America.

Max Schultze is a name familiar to all biologists as that of the originator of the term "protoplasm." He established the fact that this substance is practically identical in plants and animals. Having made these significant discoveries he turned his attention to a study of the nerve cell and made important contributions to the knowledge of the nerve endings in the nose, eye and ear. His article, "Uber die Endigungweise des Hörnerven im Labyrinth" (1885), appears among the notable presentations of his time. He examined fresh end-organs immersed in cerebrospinal fluid which latter he obtained in quantity from the ray and shark (op. cit., p. 351). He contributed the term "crista acustica," perhaps better called "crista ampullaris" (p. 346). His drawing of the crista of Raja clavata is his most accurate illustration. The others suffer somewhat from comparison with those of the present day, as, for example, with those of R. Lorente de No.

Retzius' monumental work, "Das Gehörorgan der Wirbeltiere" (1881), is evidence of the wealth of time and labor put upon the study of the auditory mechanism in the latter part of the nineteenth century, from the point of view of the pure scientist. Compiled through the activities of many excellent scientists and artists, this atlas has become the source book of information to which all modern students of the anatomy of the ear eagerly turn. The first volume comprises a study of the membranous labyrinth from cyclostomes to amphibians inclusive. The second volume is a presentation of those of reptiles, birds and man. No more accurate visualization of the labyrinth with its nerve and vascular distribution can be obtained than by a study of these exquisite plates. Retzius was born in Stockholm, October 14, 1842; he died in 1914.

Enumeration of names already familiar to the reader is but dull tribute to the honor of the many modern investigators who have increased our knowledge concerning this complicated organ. Its "minute and intricate structure" continues to attract not only the investigators of anatomy, but those of physiology, pathology and surgery.

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SYMPOSIUM ON ORAL MYCOSES.

THE CLINICAL ASPECT OF ORAL MYCOLOGY.*

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It is my belief that the clinical interest in oral mycology has suffered from the common misconception that these higher organisms so prevalent in the mouth are comparatively innocent. There has been excellent work done on the laboratory side of the problem by a few interested workers, but there is little that appears on the clinical side.

It would seem plausible to think that organisms that can undergo such pleomorphism in physical appearance can likewise change as to pathogenicity. We know that the lower bacterial forms are prone to swing about from innocence to viciousness. In this they are as human as we are. All that is required is some alteration in the living conditions. Surely we have such changes constantly appearing in the mouth, though the exact factors causing the change are not clear.

Granted then that we frequently find leptothrix, streptothrix, yeasts and other moulds in normal mouths (we also find pneumococci, diplococci and streptococcus hemoliticus in normal throats). What are we to believe when we see a violent inflammatory reaction, and when smears show a predominance of moulds? Unfortunately, Koch's postulates are not clinically practical in many of our private cases, yet there are sufficient cases where these requirements have been fulfilled to definitely incriminate these yeasts and ear moulds.

Clinical Factors Favoring the Infection: Fungi, moulds and yeasts are notoriously disseminated and ubiquitous. The presence of their spores have in the past been a nuisance to bacterial investigation. They are found in plate exposures made in the frozen stretches of the Arctics, and at high altitude obtained by planes. All fresh fruit is a source of spores,

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the dust of town and country are full of them. But as commonplace as they are, we are not conscious of them until something has begun to decay. There is surely something in a fresh ripening fruit that inhibits them, and they rarely attack a vigorous, young, growing tree. The story is different with over-ripe fruit, dead trees, sour milk and fermenting, katalizing organic matter.

The same is true in humans. In humans, except with thrush in infants, we rarely see the mouth moulds prominent in youth. They are relatively common in those past the physical zenith. Indefinitely then the general vitality and altered metabolism enters in. Mouth dryness is undoubtedly a factor in the growth of mouth moulds. We see it particularly in cigarette, cigar and pipe smokers. Moulds, monila (yeasts) and mouth dryness are distinctly uncommon in tobacco chewers, though we do see considerable tongue staining that may be deceiving. Other conditions that are predisposing are:

1. Poor dental hygiene, dental caries; in general, all causes producing bacterial overgrowth and irritation in the mouth.

2. Constipation, malnutrition, over-ingestion of sugars.

3. Metallic poisonings devitalizing mouth tissues, phosphorus, lead, arsenic and chrome poisoning.

Factors leading to alteration in the quantity and quality of the saliva should be considered independently of the dryness produced by smoking and by mouth breathing. Many indefinite metabolic states alter the saliva. Acute febrile states are common causes of temporary dry mouth. Infractions of our self-inflicted Volstead act were frequently observed to give the so-called bird-cage mouth. Chronic dehydrating states are rare, but should be mentioned. Excessive gum chewing can exhaust the saliva.

The relative acidity or alkalinity of the saliva is probably no factor, as the reaction is so variable and of such small intensity. As in pyorrhea, the acid or alkaline mouth has not been accepted as a serious factor, in spite of all attempts to bring it in.

Many cases of direct cross infections will be seen. Mouth inflammation will run through a whole family. Cultures will show identity, but very often the nature of the lesions differ.

Halitosis: This painfully embarrassing subject will now have to be interjected. As you know, the patients themselves do not notice the symptom, for even "their best friends will not tell them." Your own reaction may be that of the negro culprit who was hauled before the magistrate and asked what he had to say. His reply was: "I plead guilty and waive the hearin'." "What do you mean you waive the hearing?" asked the court. The answer came: "Well, I don't want to hear no more about it."

There is a distinct odor in these cases. It somewhat resembles that of saliva that has been collected and allowed to stand and to split up into its purin bodies.

Types of Pathology Found: The commonest finding is the furred tongue. The surface is coated white. Occasionally there is a brownish tinge, which either comes from tobacco stain or from sporulation of the mycelium. The heavier the sporulation the darker is the tongue; at times it becomes distinctly blackish, never, however, as distinctive as black tongue of acute lymphatic leukemia, the color of which is due to hemotogenous pigment. The peculiarity about sporulation is its tendency to periodicity, with two or three week intervals. It was the observation of this that led me to make my first tongue scrapings and to report a case in THE LARYNGOSCOPE in 1924. The tongue in these cases shows a hypertrophy of the fungiform papillae, they grow higher and more plush-like. Consequently the crypts between the villae are deeper and offer better growth conditions for both mycelia and bacteria. There is a great amount of superficial epithelial overgrowth and desquamation, and the tongue feels and looks like an old board that has lain out long in the weather. Scrapings show a mass of epithelium, streptothrix and mycelial threads. If taken at the right time bursting sporangia may be seen. (My advice to anyone interested in the subject is to read up everything that Dr. Weidman has written on it, and to follow his method of making smears.)

An important thing to remember is that the growth extends well down the back of the tongue into the laryngopharynx. Another distinctive feature is that the distribution is even and diffuse, never patchy nor "geographic," as in some other conditions. Fissurings and ulcerations do not appear.

Treatment: I have studied the matter of treatment seriously and have tried a host of methods. One thing is certain, the remedies used for fungi on the skin are not of service in this work. The rationale of treatment for infection of the tongue with fungi is to kill off repeatedly the surface crop. As the mycelial threads extend deep down in the intervillous crypts, it is impossible to get at them. Killing the surface crop ultimately discourages the deeper growth. The method is identical to clearing the weeds from a field by repeated mowing.

For some time I was partial to a still useful method which I hit upon accidentally, that was, the precipitation of silver in the threads after they were saturated with tanin. It works admirably well, but gives a very black tongue that lasts for four or five days. I now use more often eosin or phlorescin dye, giving the patient some to use at home night and morning. It is well to advise a preliminary gentle scrubbing of the tongue with the tooth brush with a milk of magnesia paste. Methyl violet is much less effective.

Like all fungus infections, the complete eradication is improbable. When treatment is left off, the growth will recur. Yet improvement can progress to a point where treatment is necessary but once or twice a week. It is interesting to note how stomach symptoms clear up with the improvement of the tongue. The flood of bacteria that are simultaneously present has been greatly reduced. We know that much of the germ-laden saliva is swallowed and that the acidity of the stomach is not wholly germicidal.

Vincent's Infection: Vincent's infection is subject matter with which we are all more familiar. We have cases that evince its seriousness and chronicity. We know, too, how prone it is to recur or rather re-awaken from an unseen focus. The dentists have contributed some really beautiful work in the investigation of the infection (Hopewell-Smith, Bunting, Black, Epstein, Stuart).

Mention should be made of the persistent shallow ulcers often seen anywhere on the oral mucosa. (I do not refer to aphthous ulcers, often erroneously named or diagnosed.) They are prone to appear when infection is lurking about the teeth. Superficially, the teeth may seem well cared for, yet

some small focus is responsible; the ulcers recur and recur. They often appear after the dentist has cleaned the teeth, and the dentist is blamed for infecting the mouth. Smears are usually negative. Vincent's is suspected and Vincent's organisms are often difficult to find, even when we are sure we are dealing with this infection. At times the ulceration on the palate grows deeper and perforates before healing reaction sets in. The reactions of the tissues around the ulcers is never great. Direct treatment, as in many manifestations of Vincent's, is often disappointing. Silver nitrate is undesirable, as it is apt to seal in the organisms in their tissue depths; this has been observed repeatedly by dentists interested in mouth ulcers.

This subject I will pass over with no other comment than, at times, we are more concerned with the situs of infection than is the dentist. Where teeth have been cleaned up to exclude reinfection, and where ulceration persists in tonsils, good results come from tonsillectomy, as has been observed in three cases. Others have reported perfect confidence in the procedure from larger experience.

Monilla or Yeast Infections: These innocent looking little vegetable forms have lately been basking in the popularizing blasts from "the most prominent professors of Europe" (at so much per blast). The pediatricians are now beginning to take exception to this innocence of the yeasts, and the nose-and-throat specialist may do so as well. True, there are many innocent forms found in the mouth, intestines and bladder, but again the monillas may become most dangerous. Reinfection is common.

Types: The simple thrush of infants is well known and considered innocent, though it, too, may set up severe, painful ulceration and membrane formation. When the monillas turn bad in adults they are apt to cause serious phlegmonous swellings with or without active ulceration. Pus formation is not often seen. For example, there exists a tonsillar and peritonsillar reaction that simulates quinsy. It even might be called a pseudo-quinsy. There is swelling, blue and hard; deglutition is painful, and the voice is typically altered. We have all had the experience of incising quinsies at all stages of their development. We have all seen quinsies that never did come to the abscess stage. Many would say that the pus

was there but was never found, that in subsiding it either reverted to a cold abscess or passed off by the blood stream. A different attitude will be had when many of these will show a massive yeast infection on making a smear. I have such cases in mind. In one of these, one member of the family had a pseudo-quinsy, two others had acute violent ulcerations of pillars, tonsils or soft palate. All showed yeast smears. The pseudo-quinsy case developed another identical pseudo-quinsy the next year, still with nothing but a mass of monilla on the smear. The local and internal use of iodide of mercury controlled these cases satisfactorily.

One thing that appears strange is that when the yeast-type organism runs wild, it seems to either crowd out or ingest and destroy other mouth organisms. Certain it is that one will often be surprised at the absence or scarcity of the usual mouth bacteria.

Concluding the subject, I would emphasize the need of being on the watch for mouth disorders due to other infections than bacteria. I would not accept as invariable the dictum that the higher vegetable forms are saprophytic.

1805 Chestnut Street.

SYMPOSIUM ON ORAL MYCOSES.

DENTAL ASPECTS OF ORAL MYCOSES.*

DR. C. W. RIGGALL, JR., Philadelphia.

Many conditions in the mouth encourage invasion of fungi and bacteria, and also often prevent complete recovery from the infection.

A great amount of investigation on bacteria has been done, but on fungi very little, due to many reasons, among them the difficulties peculiar to their classification, etc., and possibly not realizing their importance. Recently, however, fungi penetrating into the submucosa of a gum pocket have been demonstrated.

Regardless of antiseptic treatment, we frequently progress only to a certain point in destroying the infection; or, clinically all symptoms may disappear, then some time afterward we have a recurrence.

Aside from the bacterial aspect—structural, dental and tonsillar conditions are important factors, related in a greater or less degree.

Some chronic gum infections which have spread to the tonsil cannot be cleaned up without destroying the tonsillar infection. Likewise, a tonsillar infection may spread to the gum, and gum treatment alone will not clear up the infection completely.

Dental defects and poor dentistry, such as overhanging fillings, bad fitting crowns and bridges, gum flaps and pyorrhea pockets, serve as ideal culture tubes for microorganisms. Until they are removed they present difficult and often unsurmountable difficulties.

The most common, and also the most important diseases of the mouth, are acute ulcerous gingivitis (or Vincent's infection, or trench mouth) and chronic suppurative pericementitis (so-called pyorrhea or alveoloclasia).

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The destruction of bone, which can often only be detected by X-ray films, between and around the teeth in pyorrhea, is very favorable for the growth of the thirty to forty organisms usually found in the mouth.

In so-called "pyorrhea," a specific organism has not been found. The pockets contain the usual organisms of the mouth, but in greater concentration.

Vincent's infection, or using the more descriptive term, acute *ulcerous gingivitis*, is due to invasion and growth of *Vincent's spirochete* and the fusiform baccillus (sometimes classed as a fungi). It begins on the gingiva, extends laterally and internally, invading the loose structures between and around the teeth. Loose gum especially affords very favorable foci of infection. The gum tissue between the teeth ulcerates, pockets are formed, covered with a grayish, pasty membrane, which on removal exposes a painful bleeding surface.

It rarely involves the gum as a whole, usually appearing in patches about one or two teeth in various parts of the mouth.

The tonsils and tongue may also be involved. However, there is no visible pus. The submaxillary glands are involved, but do not suppurate.

There is a fetid odor due to necrosis and gangrene, considerable pain and bleeding about the affected area. The saliva is ropy and excessive. Temperature is 101-102°.

An increasing number of acute cases become chronic after partial treatment. After the relief of pain, many patients drop treatment and sometimes the doctor, too, is misled, thinking all dangerous infection destroyed, and discharges the patient.

An obscure pocket continues to incubate the organism, and a lower grade of virulency exists that is clinically more difficult to treat, as some drugs, effective in the acute stage, seem to be less effective in this so-called chronic type.

In chronic cases the patient first notices bleeding, possibly slight pain, the appearance of the gum may even appear normal to casual examination. Smears properly taken (along with the history) make the diagnosis.

Acute cases usually complain first of pain and some bleeding, which gradually increases. The tongue, frequently in acute cases, is painful to touch.

However, all lesions showing Vincent's and the fusiform bacillus should not be at once considered simple Vincent's (Bloodgood).

The presence of Vincent's spirochete also increases the pathogenicity of other organisms.

Both Vincent and pyorrhea conditions may be present at the same time.

Treatment: Many drugs are used for the treatment of Vincent's infection; some of the more common are: Sodium perborate (which Bloodgood of Baltimore, recommends for 95 per cent of cases, Chromic acid (from 10 per cent to 25 per cent is recommended by different men), Fowler's solution, Neoarsphenamine, Acriviolet, Iodine, Mercuric chloride, Mercurochrome, Potassium permanganate.

In *severe* cases, the most prompt results are obtained by using a specific drug for the various types of organisms.

The effectiveness of the same drug in different mouths varies. Vastine and Kielty recommend incubating smears in solutions of the various antiseptics for twenty-four hours, to find the most effective drug for that particular mouth. A drug is applied for streptococcic action, another for spirochetes and a third for amoeba.

For streptococci: metaphen, 5 per cent mercurochrome, chromic acid, peroxide, or acriviolet 1 per cent and 2 per cent; for spirochetes: 5 per cent arsphenamin, or Fowler's solution; amoeba respond to emetin hydrochlorid or quinine and urea.

Topical applications are not only made subgingivally, daily, to infected teeth, but in acute spirochetosis, nasopharyngeal treatment with 5 per cent arsphenamine may be indicated. Smears made from time to time indicate the progress of the treatment, for clinical improvement should not be confused with the improvement which smears alone indicate.

Treatment should be continued until the smears reach the so-called "residual infection," which is usually almost a pure culture.

Milder cases are frequently cleared up with the application of chromic acid alone, or sodium perborate, in conjunction with an effective mouth wash used frequently.

Structural defects are very important in infections and must be corrected to absolutely clear up the infections, as the most effective chemical agents cannot overcome such handicaps and there will be recurrence.

The drugs applied must have contact with the organisms for an appreciable length of time. The area must be kept dry with cotton rolls, to prevent the dilution of the drugs by the saliva. Flat point syringes and rubber cups aid in introducing the antiseptics into the pockets, which is very important, and if not accomplished, greatly slows up recovery.

The patient must cooperate by religiously using the prescribed mouth wash as directed at regular intervals. Office treatment alone will not clean up the infection.

Smoking must be prohibited, as it acts as an irritant and will prevent recovery. In stubborn cases it is well to check up on this, as it frequently explains very slow progress under usually effective treatment. Even one cigar or one cigarette a day sometimes is detrimental to a noticeable degree.

Pyorrhea Treatment—Radical and Conservative: In cases where the pockets are deep, a surgical operation is necessary, removing all diseased gum and bony tissue with suitable instruments under local anesthesia (Crane).

Conservative treatment consists in correcting occlusion, removing tartar, and removing infection from the gingival crevice or pockets by means of caustics and antiseptics. Of course, where there are general disease conditions they must be treated to be successful. (Slides: Maley, Wilson, Babis, Kadel.)

These patients take average good care of their mouths, using tooth brushes with average skill, also coming into the office for treatment at intervals; however, not always regular. In spite of this and various mouth washes, diseased conditions (as we all know) develop without the patient becoming aware of it until the very advanced stages. X-ray films frequently are the only means of early diagnosis. In pyorrhea conditions especially there is no pain until the disease is far advanced.

Case 1: F. A. S. Recently fungi resembling the Ray fungus have been shown in microscopic sections which had penetrated deeply into the submucosa of such a pocket as this. Patient had primary anemia. Affected area surgically removed, anemia treated, mouth condition relieved. (Upper left 1st premolar.) Vert. Py. First film made in 1929. General health good. Mouth to ordinary observation in fair shape. Teeth themselves good, not having been subject to much caries, and only the average amount of tartar is present.

Upper left first premolar showed evidence of malocclusion (patient having an unusually strong bite). The tooth on close examination showed a very slight motility. The X-ray shows atrophy beginning in the mesial alveolus. At this time the malocclusion was relieved, but the patient did not return at regular intervals for treatment. On one occasion, nine months elapsed between office treatments. The patient did attempt good home care by means of mouth washes and brushing.

However, the tooth became progressively more motile, but there was no pain. This, for this type of case, is unusual.

The second film was taken three years later (Nov., 1932). There was a gum-boil at about the apex on the root. The tooth was very loose and there was soreness on pressure and the tooth was elongated or pushed out of the socket. There was practically no recession of gum.

The film at that time shows atrophy extending now more from the distal side (changed from the mesial due to the grinding of the occlusion in the early treatment). It extends above the apex as well, and all attachment to the alveolus is destroyed. The only treatment now is extraction. Bacteriologically, this pocket is very inviting, and before the appearance of the gum-boil and the extreme motility of the tooth, would easily escape ordinary examination. Such pockets are frequently causes of the recurrence of Vincent's infection and of acute cases becoming chronic regardless of the usual effective antiseptic treatment.

Case 2: To casual observation, gums are not inflamed, very little caries, ordinary amount of tartar, slight secretion from gums on pressure. Teeth are only slightly motile in some cases, others are firm.

Patient is under treatment of his physician for kidney and gallbladder.

X-ray shows general absorption of aveolus throughout mouth. Many pockets between the teeth. There is some recession of the gums, but not as much as usually seen in such cases. Recommended treatment is extraction.

An acute Vincent infection may in a very short time so loosen such teeth that they almost fall out.

Hill (1930): The lower 3rd molars on both sides are partially impacted. A loose flap of gum partially covered the tops of the teeth. When the patient first presented himself, Vincent's infection was well advanced. Treatment brought the infection down quickly and the acute symptoms disappeared in 3 days. Due to business also patient stopped treatment in the office, but used the prescribed mouth wash. Nevertheless one month later he returned with the condition as bad as in the beginning. The extraction of the 3rd molars was recommended as soon as the infection was brought under control. This was completed and followed by several more treatments with no further recurrence.

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1420 Walnut Street.

SYMPOSIUM ON ORAL MYCOSES.

THE LABORATORY DIAGNOSIS OF ORAL MYCOSES.*†

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While the title given above would confine my subject to the mouth, it is obvious that the considerations applying there should also apply to the pharynx, the adjacent passages and sinuses, and perhaps the esophagus. It is taken for granted that a more or less "normal" mycologic flora is understood for the mouth, just as it is conceded for bacteria; leptothrices and streptothrices, for example, are familiar forms encountered in routine examinations. Whether they play a role similar to that of the diphtheria bacillus and the pneumococcus, with potentialities for producing disease on occasions, remains to be determined.

However, advances in the mycological field have not been as rapid and valuable as in the bacteriologic, and never will be. Bacteria must remain as the most active agents in the production of infectious diseases of the body at large, pending further information about filterable viruses. It still remains, however, that the study of fungi in general has been neglected and that the average general pathologist, including the laboratory pathologist, readily admits his weakness in mycological knowledge. This is due to several circumstances. In the first place, although pathogenic fungi were among the first microorganisms to receive study, the entrance of bacteria upon the scene was so rich in possibilities and introduced such unequivocal and cogent factors in producing disease that study of the fungi was largely dropped. In the second place, it is becoming increasingly difficult for the general pathologist to keep pace with the ever increasing complexities in hematologic, serologic, bacteriologic and protozoologic technique. Hence it is only a pressing demand that will constrain him to master any comparatively new subject. Add to this the fact that mycologic examinations are called for rather infrequently and

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that when called for entail an inquiry into a plant form which is extremely variable in morphology and therefore entails much uncertainty in classification and we are compelled to exhibit the utmost tolerance and sympathy with the laboratory man who is confronted with a difficult problem in determinative mycology.

Of course, this cannot excuse us in neglecting the subject entirely. Indeed, the problem must be essayed when it presents in the study of human beings compromised by disease. In this the clinician must play his part, and the attempt will be made in this paper to indicate how he can assist the laboratory worker when he submits materials to him for examination, besides giving the clinician at least a somewhat better perspective of the general situation in mycology.

It would require a monographic treatise to catalog here the fungus species which may possibly parasitize the mouth and related passages, to say nothing of their classification, technique of determination and to discuss their pathogenesis. The writer will therefore confine his subject to those few phases which may be of immediate service to the clinician as he makes his first venture into a mycologic problem. At least, the attempt will be made to enable him to avoid mistakes which might destroy or exhaust his materialss before they reach the laboratory, to say nothing of the unnecessary labor involved. It is hoped that these remarks will also enable the physician to determine whether fungus is or is not present; but, after that the question whether they are pathogenic forms and, if so, whether they are the exciting agents in the case, will generally have to be left to the laboratory worker, together with recourse to standard texts and other sources of information.

Selection of sample. The swab technique employed in routine bacteriologic examinations is not as useful in mycologic practice. It is true that in some mycoses the fungus cells are present in great abundance. However, in others they may be localized—at least, present in such form that they would not be secured by indiscriminate swabbing of the throat. It is probable that, by and large, fungus elements are less widely disseminated than bacteria—in the mouth as on the skin. Furthermore, in a study of the fungi the considerations extend beyond single cells, as in the case of bacteria; the more or less

complex arrangement of fungus cells into chains, clusters, branching forms and so forth is an important item in the determination of species and should be preserved intact if possible. Such special arrangements can scarcely be determined in the materials selected by swabbing; they are likely to become disarranged. On the other hand, particles of tissue which can be examined under the microscope in toto may reveal conformations which it would be quite impossible to discover in material from a swab.

These considerations make it advisable to attempt to secure *actual particles of tissue*, using the curette, or even small curved scissors and forceps. Pieces the size of a pin-head are appropriate, but almost anything that can be seen with the naked eye will do. Material in greater abundance is necessary in mycologic work, hence as large a quantity should be secured as is practical. At the same time the physician should attempt to envisage that portion of the lesion which is most actively progressive, i.e., where the fungus cells are likely to be viable and more abundant. The materials should be placed in the bottom of a test tube containing two or three drops of normal saline solution in order to prevent drying out; it is extremely discouraging to the laboratory worker to receive only a more or less dried-out cotton swab at the bottom of a test tube.

If it is not practical to curette or snip out materials, they may be secured by a microcurette method as follows: a piece of narrow glass tubing is drawn out into a fine pipette in the Bunsen burner (the well-known Pasteur pipette of the bacteriologist). The thin capillary tube is then broken through, is of course sterile, and its tip may now be scraped over the surface of the lesion under study, or the roof of a vesicle or abscess may be punctured with it. The pathological materials will extend by capillarity up the pipette, carrying more or less particulate matter from the lesion. In case there is insufficient fluid on the lesion, normal salt may be placed upon it before and/or during the microcurettage. Of course, the pipette will then be placed, with its contents, in a sterile test tube for transmission to the laboratory. If necessary, two or three drops of normal salt solution may be placed in the bottom of the test tube to insure against drying out. Not to appear supererogative, adequate clinical data should accom-

pany the specimen, or, what is better, personal consultation with the pathologist covering the special mycologic aspects of the case. If there is any choice, it is advisable to collect materials at a time when fungicides, particularly iodine, or iodides internally, are not being used.

Direct examination of materials. Beyond doubt the "extemporaneous potassium hydroxide" technique stands out above all others. A small particle of material, preferably thin and likely to become sufficiently transparent for microscopic study is placed upon a glass slide, a small drop of 10 per cent potassium hydroxide solution is added and the cover slip immediately applied. If it is likely that the examination is to be prolonged, the cover slip may be ringed with vaseline to prevent evaporation. If the particle of material is thick, the preparation may be gently warmed over the flame; in case of materials from the mouth, however, this is not likely to be necessary. The alkali at once clears the specimen and softens the material so that it flattens out into a comparatively thin film. This preparation is of course not amenable to staining and is examined immediately under the microscope. The physician should not be surprised at this apparent contempt for staining technique when he recalls that fungus cells are so much larger than bacterial ones in general and that they are likely to occur in filaments or branching forms which definitely reduce the difficulties of their detection.

If it is felt that the fungus cells in the case escaped detection by this technique, due to their minute size or for other reasons, the "wet Giemsa" technique may be employed. A minute drop of undiluted Giemsa stain is applied to a glass slide, the suspected material is stirred into it and the cover slip applied at once. In a few minutes tissue and fungus cells will stain blue. Additional details in their structure may be secured by flowing distilled water under the cover slip (feed at one side with capillary pipette, withdrawing at other with filter paper). The exquisite differentiation conceded for Giemsa stain may thus be secured in the wet as well as in the routine dry method. The advantage of wet over dry technique will appear later; it is particularly useful in the study of yeast cells, streptothrices and such smaller forms.

The Gram stain. This is useful only for fungus cells which are of the proportions of bacteria, such as the streptothrices

and certain extremely minute yeast cells. This is the case because in the processes of drying and fixation by heat the larger forms become distorted, frequently to such an extent that they are scarcely recognizable, even as fungus elements. Perhaps the most useful single function of the Gram stain is to distinguish between the clubbed forms which can occur both in actinomycosis* and in actinobacillosis† and which may thus result in mistaken diagnosis. In preparing the smear for this examination, as well as in other examinations of fungus material, the worker is cautioned against unnecessarily stirring up the materials when distributing them on the slide. Unnecessary stirring may disrupt filaments or other special arrangements of fungus cells which might be highly diagnostic.

The wet India ink technic. This is designed to identify the presence of a certain thick, more or less mucinoid capsule which occurs upon at least one important pathogenic yeast cell—a torula. The capsule is invisible in extemporaneous potassium hydroxide preparations, besides being extremely refractory to all stains. For detection a minute drop of India ink is placed upon a glass slide, the material is promptly stirred into it, and the cover slip applied. Only enough material should be used to barely fill the space between the slide and cover slip—it is necessary that the film of material should be sufficiently thin to allow at least a small amount of light to pass through the India ink mixture. If too much is introduced, it may of course be withdrawn with filter paper applied to the edge of the cover slip. A dark field effect is secured, the yeast cells appearing as minute refractile spherules. The capsule, if present, appears as a broad halo or court around the cell.

At this point it is proper to remark that the above techniques are applicable to materials from culture as well as from tissue. At the same time it is fitting to remind the worker of the extreme differences which many species of fungi exhibit in tissue and culture. For example, both *Coccidioides immitis* and *Blastomycoides dermatitidis* appear simply as spherical cells in tissue, but exhibit a luxuriant mycelium in culture. Similarly, the cells of *Sporotrichum schencki* appear as minute, almost bacillary budding forms in pus,

*Gram positive filaments.
†Gram negative filaments.

whereas in cultures they exhibit rich networks of mycelial filaments and spores.

Culture. It has been remarked already that the cells of fungi are far larger than those of bacteria and that their arrangements (filaments, branching forms and so forth) are much more elaborate. Furthermore, their colonies are as a rule much more luxuriant and bulkier. Too, it requires a longer period of time for them to develop their maximum and characteristic stage of development in the test tube. These peculiarities of behavior at once require certain departures from conventional bacteriological techniques. Due to the size of the colonies, the containers must be larger—test tubes 15 x 2.5 cms. are far more useful than the smaller ones used by the bacteriologist. Fungi, too, require an abundance of oxygen; these larger tubes aid in this respect. The petri dish is far less useful for mycologic work than bacteriologic because it is difficult to keep the medium from drying out during the more prolonged growth which is necessary for fungi. Some fungi, for example, must be kept for four or more weeks before arriving "at prime." Hence the use of the large test tubes just mentioned in preference to petri dishes. Indeed. some fungus colonies become so large that they cannot be accommodated even in large test tubes; in such cases they are planted in Erlenmeyer flasks containing a stratum of medium 1 cm. thick. The colonies developing under such circumstances are known as giant colonies.

Sabouraud's medium is almost a byword in the culture of fungi. As a matter of fact, its value depends largely upon its low pH—about 4.6. This is due to the particular variety of peptone employed by Sabouraud, i.e., that of Chassaing, and which is imperative as an ingredient. The low pH is important in two respects: first, it will inhibit the development of many contaminating bacteria, facilitating the obtaining of pure cultures. Of even more importance is the fact that the characteristics of the colony which are of such value in determination can be brought out only upon such a medium. In extensive tests conducted in this laboratory it was found that American, particularly Difco, brands of peptone were entirely inadequate for most of the fungus species tested. For this reason Chassaing's peptone is stocked by American laboratory supply houses. A further ingredient, but which is unnecessarily emphasized for Sabouraud's medium, is the crude

maltose. Sabouraud himself now concedes that the particular French brand of Chanut is not essential. It appears that a *crude* American glucose serves the purpose just as well, but it must be crude.

Note must be made of an exception to the general rule indicated above about the pH of the medium. Thus, the streptothrices (which include the actinomycetes and is synonymous with Nocardia) do not grow well on acid media. Glucose agar of pH 7.8 employed by the bacteriologist is much better.

Ordinarily the fungi of the mouth can be isolated on solid medium. However, experience in other regions of the body, notably the skin, show that occasionally success is achieved only after resort to glucose bouillon.

Animal inoculations. These frequently become necessary in view of the ever-present question in all specialties whether the microorganism obtained from the lesion is necessarily the pathogenic agent in the case. This is particularly cogent in a place like the mouth, where so many secondary or even saprophytic invaders may be omnipresent. In tests for pathogenicity the rat is the animal of choice, although there are certain exceptions which cannot be cited here. Cultures injected intraperitoneally are, in the case of the pathogenic organisms, most likely to induce lesions in the kidney and in the testis, besides the peritoneal surface itself. Naturally the mesenteric lymphnodes show particular involvement in the latter case. Involvement of the testis is much more consistent than with bacterial infections in general. It is analogous to the well-known Strauss test for glanders.

Determination of species. The final steps in a complete diagnosis of a mycotic infection is of course the determination of the species concerned. This is a complicated procedure, even for the skilled mycologist, except when dealing with one of the commoner and well-known microorganisms. This is due to the notorious variability of fungus species, not alone as between tissue and culture, but even in different culture tubes containing the same medium. Naturally this entails difficulties in the classification of fungi in general which in turn extends to the identification of any particular species under study. For the purposes of this communication then, little more can be done than to submit the following list of texts to which reference may be made:

Castellani and Chalmers: Tropical Medicine. Third edition, William Wood and Company, 1920. For a good bird's-eye view of the situation medically; visceral as well as mucocutaneous mycoses. Classification followed is that of Vuillemin, and is one of choice in medicine.

Castellani, Aldo: Fungi and Fungous Diseases. Amer. Med. Assn., 1927 and 1928. Appeared serially in *Arch. Derm. and Syph.*, Oct., Nov., and Dec., 1927, and Jan., Feb., and March, 1928; pp. 383, 571, 714, 61, 194 and 354, respectively.

Castellani, Aldo: Milroy lectures on the Higher Fungi in Relation to Human Pathology. *Jour. Trop. Med. Hygiene*, May 1, 1920. Splendid dissertation on thrush, indicating wide range of fungus species capable of causing thrush.

Henrici, A. T.: Molds, Yeasts and Actinomycetes. Wiley, 1930.

Guilliermond and Tanner: The Yeasts. English translation from the French, Wiley and Sons, New York City, 1920.

Langeron, M.: Precis de Microscopie. Masson et Cie, Paris, 1913, pp. 702-720.

Thom and Church: The Aspergilli. Williams and Wilkins, Baltimore, 1926, p. 272. Complete consideration of the subject—morphological, chemical and physiological.

Thom, C.: The Penicillia. Williams and Wilkins Company, Baltimore, 1930.

Type culture collections. For first-hand comparison with a strain which he has identified and wishes to confirm, the worker can obtain type strains of fungi from certain collections maintained both in the United States and abroad as follows: American Type Culture Collection, 637 S. Wood Street, Chicago, Illinois (2000 strains); National Collection of Type Cultures, Lister Institute, Chelsea Bridge Road, London, S.W., 3 (800 strains); Central Bureau of Fungus Cultures, Javalaan 4, Baarn, Holland (3753 strains).

CONCLUSION.

Due to the scarcity of trained medical mycologists, together with the dominant role played by bacteria in infectious diseases, the part of fungi in producing human diseases has been

unduly neglected. In a place like the mouth and its adjacent passages conditions are particularly favorable for the growth of fungi, inviting much more searching inquiry into the subject than has thus far been accorded it. Among other things, the grosser proportions of fungi, compared with bacteria, entail a technique that differs materially in many respects from that of bacteriology. The attempt is made in this communication to indicate certain special measures to be employed in collecting the materials, in methods of immediate direct examination, in methods of culture, and to a less extent, tests upon animals. In the present state of medical mycology the exact determination of the identity of fungus species is impractical in routine laboratory work, except for the better known forms, such as actinomycosis and sporotrichosis. The accurate and final determination of the remainder is usually a matter for the qualified mycologist.

It is unfortunate that this is the case and that the number of such mycologists is so small. There is urgent need for a number of mycological "centers" scattered over the United States. To these the increasing numbers of suspected fungus infection could then be referred.

Laboratory of Derm. Research, U. of Pa.

EXPERIMENTS ON THE UTRICLE.*

DR. W. J. MCNALLY, Montreal.

In this short communication I shall discuss just a few of the interesting things which have arisen in the course of our experiments upon the frog's labyrinth. This research has been carried out in conjunction with Professor John Tait of the Department of Physiology, McGill University, Montreal. These experiments are all discussed in greater detail in a joint paper shortly to be sent for publication.

During the course of our experiments improvement has taken place along three main lines: (1) the operative technique has been improved; (2) the methods of observation and examination of the animals have been greatly amplified; (3) our knowledge of the symptomatology of labyrinthine lesions has increased.

Uncomplicated operative lesions upon the utricular macula, its otolith or nerve have always been difficult to carry out because of the inaccessible position of the utricle in most animals. The function of the utricle has therefore had to be inferred. One of the first successful operations upon the utricle was done by Versteegh (1927) upon the rabbit. He succeeded in cutting the nerve to the utricle. Two years ago we succeeded in being able to sever the nerve to the utricle in the frog, leaving all the other labyrinthine structures intact. With practice it has now become possible to cut the nerve to the utricle on one or both sides and if it is desired any combination of canal lesions can be associated so that the post-operative reactions can be checked by any combination of operative lesions.

Today I shall consider just two main groups of experiments: when the utricles are intact and all other labyrinthine structures have been removed, i.e., the nerves to all other labyrinthine structures have been severed; and second-

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ly, when the nerves to the utricles have been severed and the remainder of the labyrinth is intact.

The first group of experiments are positive because the utricles are the only labyrinthine structures still functioning, and therefore any labyrinthine reactions observed must be true utricular effects.

When a frog with only two utricles intact is observed it is seen to be as a rule symmetrical when at rest. There is a slight widening of the base of support. The righting reflex is present, but not quite so prompt as usual. It is during movement, whether spontaneous or induced, that disability is noted. If the animal jumps the movement is clumsily done, and it may stumble towards any corner of the body on landing. Instead of coming to rest, a rhythmic pendulation begins when the animal attempts to recover from the stumble, and it may sway from side to side, or fore and aft, or in any diagonal direction for as many as ten or twelve times before finally coming to rest. This pendulation may come on at the beginning or end of any movement which affects the frog's head. When subjected to quick tilting about a horizontal axis a frog which has only the two utricles intact makes a prompt movement in the direction of the tilt; for instance, if tilted backwards the head moves upwards and backwards. This is followed by a downward sweep of the head. Several backward and forward oscillations may occur before the frog comes to rest. The striking thing, however, is that the prompt response of a frog with only two utricles intact is to move in the direction of the tilt. This is the opposite direction to the compensatory reaction of a normal frog or to the response from a semicircular canal. In a delabyrinthised frog such a movement in the direction of the tilt does not occur, the animal remains inactive and goes with the table, so that it is more than an inertia reaction. This reaction first came to our attention when we removed a single posterior vertical canal in an otherwise normal frog. When tilted in the direction of the absent canal the head goes upwards and backwards towards the operated corner. At first we were at a loss to explain this reaction and it was only when we were able to do these experiments upon the isolated utricle that the full significance of this movement in the direction of the quick tilt became clear; it is evidently a utricular effect.

If slowly tilted about a horizontal axis such a two-utricle frog makes a true compensatory reaction. It is to be noted that the reactions occur in very definite shifts; it is not a continuous movement so that one receives the impression that the frog is receiving interrupted messages from its utricle which brings about these shift-like compensations. These shifts are in the opposite direction to its response to a quick tilt.

The things to be noted about the two-utricle frog are that its posture is symmetrical; that it is able to right itself; that it is disturbed by pendulation during any movement; that in response to a sudden tilt its body moves in the direction of the tilt; that in response to slow tilt it makes a true compensatory reaction; and finally that these compensatory reactions are interrupted or shift-like.

In a group of frogs we removed one of the two remaining utricles so that we then had a one-utricle frog, all other labyrinthine structures in each labyrinth being out of action. This frog is able to right and also shows pendulation. Such a frog is asymmetrical in that it leans down to the side of the absent utricle. The lean however is not so marked as that of a unilaterally delabyrinthised frog. As demonstrated by Beritoff (1928), in the case of frogs with one labyrinth removed, it is possible to impose upon the one-utricle frog a symmetrical posture by carefully manipulating the head and the new symmetrical posture will be maintained for some considerable time till the frog is jarred or till it makes a spontaneous movement. This fact suggests that the utricle is not constantly signalling and that it is only in response to a slight displacement of its otolith that the utricle comes into play and breaks up the existing symmetrical posture and dictates the new pose. This idea is further strengthened by the fact that the two-utricle frog reacts to slow tilting by interrupted shifts as though in response to slight displacements of the otolith on the macula.

These experiments would indicate that the utricle is stimulated by a displacement of its otolith and that it is not continuously signalling; that it is in great part responsible for the down lean of a unilaterally delabyrinthised frog; and that in response to a sudden tilt it elicits a reaction of the head in the direction opposite to true compensation.

In our second group of experiments the nerves to the utricles were severed, leaving the other labyrinthine structures intact.

At rest the de-utriculate frog is symmetrical. It is able to right very promptly so that in the frog the utricles are not an essential part of the righting mechanism. This frog shows a very marked tremor on attempting any movement which is very different from the pendulation of the frogs just described above. The tremor is more suggestive of that of paralysis agitans. Forward progression is in some way interfered with in this frog so that it is loath to jump. If left on the floor for a considerable time it will not move out of a small circle.

The responses to quick tilting are very marked. The response is in the direction of true compensation, but it may be so strong as to tend to upset the animal in a direction opposite to the tilt; for instance, if the animal is tilted backwards the animal may not only protect against the backward tilt, but it may actually be driven forward. The head is lowered and the legs are extended in such a manner as to drive the body forward, the reaction being very much more extreme than that of a normal frog under similar conditions.

If only one utricle has been removed, the frog has a lean down to the side of the absent utricle, but the lean is not so marked as when the whole labyrinth has been removed on that side. The explanation of this will be given in our more detailed paper.

When a uni-de-utriculate frog is subjected to quick tilting its reactions are normal when it is tilted to the side of the operation, whether the tilting is backwards or forwards to that side in the plane of either the anterior or the posterior vertical canal. However, if the tilting is towards the non-operated side in the plane of either the anterior or posterior vertical canal, the reaction is in the sense of true compensation, but as described for the de-utriculate frog the strentgh of the reaction is out of proportion to the stimulus and would seem to be designed to upset the animal in a direction opposite to the quick tilt.

Because this reaction only occurs when the canals of the intact side are stimulated, it would suggest that they must,

under normal conditions, be affected by the utricle of the opposite side. When the opposite utricle is missing the response from these canals on the non-operated side becomes very much more marked.

This last group of experiments indicate that the utricle is not essential to righting, but that its presence is necessary for sustained forward progression. The presence of tremor in these de-utriculate frogs suggest that the utricle must be acting during movement in the normal frog to prevent it. Since, in the absence of the utricles, the canal reactions are unduly strong, it would indicate that the utricles must exert a modifying influence upon the vertical canals, one utricle being more concerned with the canals of the opposite side.

It has been drawn to my attention by Dr. T. Hoen, St. Luc's Hospital, Montreal, that a somewhat analogous relationship would seem to exist between the cerebrum and cerebellum. In the absence of the cerebellum or in grave cerebellar lesions one of the prominent symptoms may be dysmetria. The movements of the affected limbs are ill-measured (Gordon Holmes, 1917). If the patient is asked to carry out a definite limb movement there is no precision; it may be overdone; the amount of muscular energy put forth is disproportionate to the contemplated movement. The cerebrum is over-acting in the absence of the cerebellum. Is it possible that the overacting vertical semicircular canals may be likened to the cerebrum and the moderating utricle be analogous to the cerebellum?

SUMMARY.

The utricles are not an essential part of the righting mechanism in the frog.

They are necessary for sustained forward progression.

The adequate stimulus of the utricular macula is probably not the pull or pressure of its otolith, but rather some slight displacement of the otolith.

The utricle is stimulated by any sudden tipping movement and the reaction elicited may be described as negative or opposite to true compensation.

The negative reaction and the existence of pendulation in the frog with only utricles intact suggest that normally these reactions must be checked by the canals.

The unduly strong reactions from the vertical canals of the de-utriculate frog to sudden tilting suggest a regulating influence of the utricles over the canals in the normal frog.

Since the reactions of the utricle or of a canal to a quick tilt in a certain direction are oppositely directed, it is probable that in the normal animal the utricle and the canal oppose each other, the canal effect predominating, so that just the exact amount of compensation is rapidly effected.

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RECOVERY AFTER STREPTOCOCCIC MENINGITIS FOLLOWING OTITIC SEPSIS.*

DR. LOUIS KLEINFELD, New York.

The patient, a woman of 38, had suffered from bilateral discharging ears since childhood. A radical mastoidectomy had been performed 20 years ago on the left side. In May, 1932, a radical mastoidectomy was done on the other side because of vertigo and a positive fistula test. At this operation there was found, in addition to the usual cholesteatoma, a necrotic area on the external semicircular canal. One week later, at the first dressing, the patient had an attack of acute labyrinthitis (vertigo, vomiting and nystagmus, followed by high fever and signs of meningeal irritation), all of which subsided under conservative therapy in about two weeks.

She came under my observation about a month later, in July, 1932, at which time there was still present a slight, sometimes foul, discharge from the right ear, which was completely deaf when tested with the Barany noise apparatus. There was a foul discharge from the left ear, the hearing of which was moderately impaired. Neurologic examination was negative except for vertigo on turning suddenly.

Two weeks later, the patient complained of a frontal headache. The next day the temperature reached 103°, associated with questionable neck rigidity. Lumbar puncture disclosed 1500 cells, mostly polys. The blood showed 15,000 cells, of which 80 per cent were polys. Hemoglobin was 80 per cent. In view of the history and findings, it was decided to do a labyrinthectomy on the right ear, which was done on the following day by Dr. I. Friesner and myself in the Private Pavilion of Mt. Sinai Hospital. The mastoid cavity was found filled with healthy granulations. A granuloma was seen on the external semicircular canal. The operation consisted of opening the three semicircular canals, the cochlea and the vestibule.

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The post-operative temperature ranged from 103-106°, associated once with a chill lasting 10 minutes. Several blood cultures were negative, but finally a growth was obtained in an especially delicate medium, the cocoanut flask, which was reported to be Streptococcus Hemolyticus. (An unusual feature of the clinical course at this time was the occurrence of agonizing pain in the lower lumbar region, preceding each rise of temperature. This symptom, plus the history of previous renal colic, led me to have the renal tract investigated, with negative results.) In view of the positive blood culture, the preceding labyrinthitis and the generally septic course, I decided that there had been an extension of the infection from the labyrinth to the labyrinthine veins, then to the inferior petrosal sinus and finally to the jugular bulb. Consequently, I proceeded to ligate the right jugular vein and expose the sinus, which I was unable to open because of excessive bleeding from the junction of the emissary vein and the lateral sinus. Iodoform plugs were inserted (at the proximal and distal ends of the exposed sinus), and the patient sent back to her room in rather poor condition. During the following week, two attempts to open the sinus were unsuccessful owing to free bleeding from the sinus as soon as the plugs were removed. However, the general condition improved and the temperature fell to 100°. Nevertheless, the occurrence of a paresis of the right external rectus and an increasd left knee-jerk caused us some anxiety. (A confusing element was introduced by a flare-up in the other ear, shown by a marked loss of hearing in this ear, as well as by an increased quantity of foul discharge.) On August 5th, three weeks after the labyrinthectomy, the patient had a convulsion, followed by a flaccid hemiplegia on the right side. There was a bilateral Babinski and beginning papilledema. The spinal fluid showed 250 cells, mostly polys. The blood count was 24,000 W.B.C., of which 75 per cent were polys. Based on the neurologic findings, a diagnosis was made of a possible lesion in the left temporal-sphenoidal lobe, either metastatic from the right jugular bulb, or an extension from the suppurating left ear which had flared up.

I now made a third and successful attempt to open the sinus, which was found to be collapsed. Through an incision in the sinus wall, a small rubber catheter was passed into the bulb, which was then irrigated daily with Carrel-Dakin solu-

tion. There was a dramatic improvement for the next three days, the white count dropping to 12,000, with 75 per cent polys. The hemoglobin at this time was 75 per cent. The neurologic signs abated except for the right external rectus paresis and the papilledema. The next day, however, there was a rise in temperature plus a Kernig. The spinal fluid now contained 4000 cells, of which 75 per cent were polys. There were no organisms on smear, but culture was positive for streptococcus hemolyticus. An exploratory craniotomy was performed by Dr. Ira Cohen with negative results. At this operation fluid was aspirated from the lateral ventricle, which was later reported as sterile. In view of the positive spinal fluid culture a hopeless prognosis was given and no further laboratory tests were made. To our amazement, however, the patient's condition improved steadily and she ultimately made a complete recovery.

In summing up this case, I feel that the course of events was as follows: A radical mastoidectomy was complicated by a suppurative labyrinthitis, which subsided under expectant therapy, but which later flared up, causing an extension to the jugular bulb in spite of an early labyrinthectomy. A blood stream invasion then took place, which led us to tie off the jugular vein and expose the sinus. The neurologic signs that then appeared simulated a left sided brain lesion, but this was not found at operation. (Incidentally, various neurologic signs may appear after jugular ligation, closely simulating brain suppuration, possibly due to retrograde thrombosis of small pial veins.) Streptococci were then found in the spinal fluid, apparently few in number (since they could not be detected on direct smear, but only on culture) and it was due to this, in my opinion, rather than to any therapy, that recovery took place.

In conclusion, the purpose of presenting this paper is to call attention to the fact that the presence of streptococcus hemolyticus on culture of the spinal fluid is not necessarily of fatal import.

17 East 84th Street.

THE USE OF THE FRESH SHEEP HEAD FOR TEACHING THE TECHNIC OF THE SUBMUCOUS RESECTION OF THE NASAL SEPTUM.*†

DR. WALLACE MORRISON, New York.

In teaching the technic of the submucous resection of the nasal septum to students, the author has found that the usual "wet" specimen used for the demonstration is often very unsatisfactory; it is virtually impossible to obtain the fresh human material which would be ideal for the purpose; the usual methods of instruction from drawings or charts only, and that of allowing the student to learn the basic steps upon the living patient, both fall short of being fully satisfactory. The author offers the suggestion that the fresh sheep head is a substitute of many advantages. The head of the fresh-killed sheep is usually thrown away at the abattoir, but any butcher will obtain one for a very small sum, if ordered in advance. The skinned head is very readily prepared for the demonstration of the technic, or for practice by the student. The nasal septum of the sheep is very much like that of the human, except in general shape, and in the fact that it is composed of cartilage throughout. The fresh tissues exactly resemble those of the living human septum in color, texture, flexibility and in lending themselves to the operative procedure.

To prepare the skinned head for the purpose, the lower jaw is sawed off by a horizontal saw-cut through the rami of the lower jaw, leaving the palate intact (Fig. 1). The cranial portion of the head is then sawed into three sections by two vertical saw cuts, each two centimenters from the median line of the skull (Fig. 2). The center section contains the nasal septum (Fig. 3). It is clamped between two wooden

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†From the Department of Rhinolaryngology, New York Polyclinic Postgraduate Medical School and Hospital, New York.

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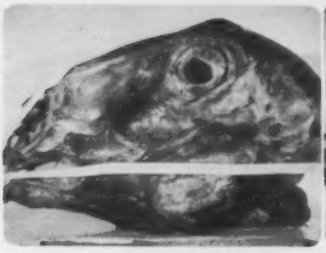

Fig. 1.

Fig. 2.

Fig. 1. Side view of sheep head with horizontal line of saw cut for the removal of the lower jaw.

Fig. 2. Top view of sheep head with two lines of saw cuts to prepare the nasal septum for the submucous operation.

Fig. 3.

Fig. 4.

Fig. 3. Center section of sheep head with the nasal septum in side view.

Fig. 4. Section of sheep head with nasal septum clamped between wooden battens for the submucous operation.

Fig. 5.

Fig. 6.

Fig. 5. Illustrating a step in the submucous resection of the sheep nasal septum. The incision of the mucosa.

Fig. 6. Illustrating another step in the submucous resection of the sheep nasal septum. The elevation of the mucosa.

battens of suitable size by means of two C clamps (Fig. 4). To hold the specimen rigid, and so that it may be readily seen on both sides under good illumination by a number of students, the lower ends of the wood battens are held in an ordinary vise on the edge of a table. Quite a large group can now watch the operator, or each student may himself perform the steps of the procedure under the guidance of the instructor (Figs. 5, 6). Since the sheep heads are inexpensive, readily obtained and easily prepared, one may be supplied each student with little trouble. Once the student has seen and performed the standard operation, further practice under conditions almost exactly like those in operating on the human nose may be duplicated by tieing the three sections of the cranium together with a strong cord, in their normal relation. The steps of the operation are now carried out through the nostril with the nasal speculum, using the head mirror and reflected light, and with the regular septal instruments until every difficulty in learning the technique has been made clear. At any time the head may be taken apart again to allow of close inspection of any step of the technique.

30 East 50th Street.

CASE PRESENTATION OF BRAIN ABSCESSES ORIGINATING IN OTORHINOLOGICAL FOCI.*

DR. LEO M. DAVIDOFF, New York.

Four cured cases of brain abscesses are being presented this evening, all of them originating in otorhinological foci. These patients are all children and, at the time of admission to the New York Neurological Institute, all had a history suggesting abscess of the brain of sufficiently long standing to permit a classification of these abscesses as chronic. Only one of these children, however, had a probably sterile abscess. The others all showed streptococcus hemolyticus on culture. The abscess in each case had a fairly firm wall. The treatment in all four cases was similar in that the abscess cavity was thoroughly emptied and its inner walls completely inspected, after which the cavity was washed with Dakin's solution and a soft rubber tube drain left in place.

Case 1: P. G., aged 13 years, was admitted to the New York Neurological Institute on May 27, 1932. Complaint: headache, vomiting, pains in the right eye, drowsiness. The patient gave a history of acute right otitis media at the age of 6 years, and has had continued drainage ever since, with exacerbations of symptoms whenever she has a cold. In March, 1932, she had influenza, which was followed by headache, vomiting and drowsiness. Lumbar puncture was performed and showed 2500 cells. After repeated punctures, she improved. In April, 1932, she again had fever, headache and coma. Her condition was diagnosed as acute mastoiditis and she was operated. A chronic process was found. The lateral sinus was opened and found negative. The dura was then opened and the brain probed. Some soft tissue was removed and microscopic examination showed streptococcus. Following this operation the patient became conscious and seemed well except for a small cerebral hernia for about one

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month. Three days before her admission to the Neurological Institute, in May, 1932, she developed severe headache, vomited, had fever and pain in the right eye. Neurological examination showed left hemiparesis, left positive Babinski, left lower facial weakness, bilateral papilledema, 2-3 diopters and slight left homonymous upper quadrantic visual field defect. The white blood count was 20,000, 86 per cent polymorphonuclear leukocytes. The temperature varied from 100 to 101 degrees. On June 3, 1932, operation was performed. Entrance was made through a clean field over the temporosphenoidal lobe. A moderately well-encapsulated abscess was found, containing about 30 cc. of greenish pus. The cavity was completely evacuated, the walls inspected, irrigation done with Dakin's solution, and a soft rubber drain left in. Culture showed streptococcus hemolyticus. The patient was discharged from the hospital on July 17, 1932. The post-operative course has been uneventful except for a slight discharging sinus, which had closed at the time of release from the hospital.

Case 2: I. L., aged 7 years, was admitted to the New York Neurological Institute on May 14, 1932. Complaint: right hemiplegia and loss of weight. P. I. began March 1, 1932, with pain in the right ear. The drum was incised, resulting in discharge of pus. One week later the discharge stopped. The earache returned later and the operation was repeated with good results. On March 20, 1932, there was again fever, pain behind the right ear with redness, swelling and tenderness. On March 29, 1932, a right mastoidectomy was performed. An acute condition was found. The result was satisfactory until April 8, 1932, when the patient had a convulsion, chiefly on the left side, followed by left hemiplegia, apathy, anorexia and loss of weight. Neurological examination showed a thin, pale, apathetic child with left hemiplegia and papilledema, 3-4 diopters, both eyes. The temperature varied from 99 to 100 degrees. The white blood count was 10,000, 78 per cent polymorphonuclear leukocytes. On May 23, 1932, operation was performed. Through a clean approach, an enormous abscess was found, containing about 75 to 90 cc. of pus with three connecting cavities. The inner wall was inspected, the cavities irrigated with Dakin's solution and rubber tube drains used, one in each cavity. Culture showed streptococcus hemolyticus. Post-operative course was uneventful. The patient was discharged on July 5, 1932.

Case 3: S. P., aged 13 years, was admitted to the New York Neurological Institute on April 25, 1930. Complaint: unsteadiness, falling to the left, headache, vomiting, diplopia, loss of weight. P. I. began February 15, 1930, with left earache, which was followed the next day by a discharge of pus from this ear. The discharge continued for two weeks. The child was apathetic and nauseated. After this period of two weeks, she returned to school. One month after the onset of the earache, the patient began to have vomiting and extreme incoordination of the left side, with severe headache. Two weeks later she had diplopia. Examination showed an emaciated child with signs of excessive involvement of the left cerebellar hemisphere. There was early papilledema. The temperature ranged from 99 to 102 degrees. The white blood count was 9,000, 67 per cent polymorphonuclear leukocytes. Otological examination showed the left ear to be negative and the right ear to contain an exacerbation of a chronic inflammation. X-ray showed density of the right mastoid. Operation was performed on May 7, 1930.

Because of the frequent occurrence of a cerebellar tumor in a child of this age and the confusion as to sides, the patient was operated for a questionable cerebellar tumor. A preliminary puncture of the left cerebellar lobe met resistance, but no pus. A wider exposure was made and the hemisphere transected. At a depth of 4 cm. the capsule of the abscess was disclosed. This was incised, the abscess drained, the cavity washed out and a drain left in place. Culture was negative for two days, and then showed staphylococcus albus (believed to be contamination). Recovery was uneventful. The patient was discharged on June 3, 1930.

Case 4: B. E., aged 8 years, was admitted to the New York Neurological Institute on April 17, 1932. Complaint: headache, vomiting, diplopia and unsteady gait. P. I. began February 8, 1932. The temperature ranged from 100 to 102 degrees. Her condition was diagnosed as grippe. She recovered in six days. A report from an otolaryngologist at this time indicated tenderness over the right frontal sinus and slight cloudiness of the right sphenoid, ethmoid and antral sinuses. One week after recovery the patient had severe headache and a chill. The temperature was 104 degrees. Then for 12 days the temperature ranged between 101 and 104 degrees, with continuous headache. This state of affairs continued

off and on until admission, at which time the patient began to see double. There was slight left facial weakness, but this was attributed to an old Bell's palsy. She had dizziness when sitting up, and a slightly unsteady gait. Neurological examination showed a thin, emaciated child, with some unsteadiness of the left side. Papilledema, 2 diopters, both eyes. The temperature varied from 99 to 100 degrees. The white blood count was 7,200, 60-75 per cent polymorphonuclear leukocytes. On May 11, 1932, exploration of the left cerebellum for abscess was done by another surgeon, but no abscess was found. After this procedure there were signs of definite left hemiparesis. On June 7, 1932, a right frontal exploration was performed. A very large abscess was found and emptied, and the cavity was inspected and washed with Dakin's solution. Rubber tube drain was used. Culture showed streptococcus hemolyticus. Post-operative course was uneventful. On August 12, 1932, the patient was discharged.

Three of these children have now gone one year since their operation without neurological symptoms. Two of them had temporo-sphenoidal abscesses; the other, a right frontal lobe abscess. The fourth child, with a cerebellar abscess, was operated three years ago and is entirely well today.

6 East 85th Street.

NEUTROPENIA.*

DR. PAUL REZNIKOFF, New York.

Three types of neutropenia are usually encountered in practice. The first is infectious neutropenia, characterized by a low total count and an absolute decrease of all the cells. The polys, however, are not usually decreased relatively. The interesting feature about infectious neutropenia is that experimentally all infections usually start with this type of neutropenia. Dr. Goodner, of the Rockefeller Hospital, found a neutropenia as the first evidence of experimental pneumococcus infection long before the animal showed fever or a positive blood culture. In many of the patients who came under observation early, such as a patient who developed pneumonia in the ward, it is not uncommon to have neutropenia immediately. These infectious neutropenic patients have an absolute neutropenia rather than a relative one, and in most cases with favorable outcome a rapid increase of cells occurs.

The second type of neutropenia is characterized by depression of the entire hematopoietic tissue, myelophthisis of the bone marrow. It is not uncommonly seen in patients treated with organic arsenicals. The patient has a marked depression of the neutrophiles as well as the red blood cells and platelets. A similar type of picture is seen in some stages of aleukemic leukemia, although the bone marrow is not depressed.

The third type of neutropenia which we know as granulocytopenia or agranulocytosis, is very important in the laryngologist's field, for often the condition is associated with some lesion of the throat. The usual course of events in agranulocytosis is first a depression of the neutrophiles. The patient may have 5000 or even 7000 white blood cells, but has a marked depression of the polymorphonuclear cells. When

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the patients show a marked depression of the white cells and also of the red cells, it is very rare that these patients have real agranulocytosis. We are convinced that many cases reported in the literature as agranulocytosis are really infectious leucopenia or aleukemic leukemia. Most of us do not think granulocytopenia is an entity, but a deficient response of the patient. It is seen most often in females, and usually in adult females; it is seen in connection with a variety of causes, infected teeth, menstruation, trauma. Many of the patients say they always feel rather sick before or just after the menstrual period, and if the blood count is taken they are found to have a depression of the blood cells. It is not uncommon for such patients to have an attack during the menstrual period. One of our patients had a typical attack of granulocytopenia and recovered. A year later she was out riding and had an accident in which her nose was fractured. Knowing her history, a blood count was taken and she showed a marked granulocytopenia. So we find that we are dealing with a number of causes and not with one disease; but really with a constitutional condition which may manifest itself due to one of several causes, even in the same patient. Recently we have had some confirmation of this by the work of Dr. Lawrence Smith of the Willard Parker Hospital, who found in seven of eight adult patients who died definite thymus tissue. So we are forced to believe that it is a constitutional defect rather than a disease. It is interesting to note that these patients come to the laryngologists because they have sore throats. Most of them whom we have been able to follow say that they felt well until they had sore throats; but we also found a very striking fact, *i. e.*, that the first thing that happens is the depression of the white blood cells, especially of the neutrophiles.

One patient came to us for a daily blood count for 8 months. One day she showed 5000 white blood cells, but only 5 per cent polys. She was kept in the hospital and still said she was feeling well, but the next day she complained of a scratching of the throat, and very rapidly the throat took on the typical picture of agranulocytosis. This is very important, for it shows that these patients have first a disease of the bone marrow, and secondly of the throat, and when they come to us for the throat condition they have been sick for a relatively long time with depression of the bone marrow.

Now, what happens to the throat as we follow it? The first thing we notice is a little injection, very slight; the patient complains of a little scratchy feeling; the temperature is not much above normal—99.5 degrees. Very rapidly the throat becomes diffusely involved, but differently than in simple tonsillitis, in which it is bright red in appearance. The throats of these patients appear purplish red. There are no bright red streaks. The lesions that these patients have on their skin are the same, and if you examine the skin lesions there are no polymorphonuclears, and we are forced to conclude that one of the striking characteristics of the absence of polymorphonuclear cells is this purplish color. Immediately after that, if the patient progresses unfavorably, we have a marked edema, which is a constant characteristic, and immediately after the edema we see necrosis and sloughing. An interesting feature to the nose and throat men is the tremendous enlargement of the submaxillary lymph nodes. Many patients suffer with intense dyspnea.

There is no specific treatment of the throat. Many physicians use mercurochrome and arsenicals, which are contraindicated. In our experience the only thing to do is to treat the lesion conservatively with irrigations and an ice collar to the neck, if that gives comfort. If the blood returns to normal the patient will recover, and if not the patient will die. I think it is a mistake to treat these local conditions too drastically, for the essential lesion is in the bone marrow.

I would like to say one word more about the treatment. I might make myself clear by saying that unless we can reproduce this condition in animals, there is no scientific way of determining that we have a specific substance in treating granulocytopenia. I have said it is constitutional, and that it is difficult to reproduce the picture. We have tried for years, using benzol, X-ray, arsenicals, infection, etc. You may have depression of the entire bone marrow, but it is not a reproduction of this picture, and if we cannot reproduce it in animals we have no justification for saying that the patients recover because of any particular type of medication. Of the patients who recovered under our treatment, we have evidence to show that some recovered spontaneously. We are sometimes led astray when the patient has recovered after a certain type of treatment.

If daily smears are studied during an attack of agranulocytosis the first change in the blood picture is a monocytosis before the neutrophiles appear in any number. Many patients show this monocytosis before therapy is instituted. What causes them to recover is a matter of dispute. I might say that all sorts of things cause recovery. For instance: one patient I studied, a graduate nurse, had a neutropenia at every menstrual period. She became pregnant, and showed the typical picture of pregnancy, a leucocytosis and an increase of immature polys and delivered a normal child. Since the pregnancy she has had no attacks. It is difficult to explain why she recovered. An interne had two attacks. Two infected teeth were removed and he has not had another attack for three years. With another patient the only thing found was a stasis of the duodenum. Her blood has been in good condition since she was operated upon. Another factor is the relation between this condition and menstruation. One patient has had three attacks and although she has had a normal blood count for half a year, a vaginal smear invariably shows leucopenia at the time in her cycle when it should show a leukocytosis.

Among the therapeutic methods employed are transfusions. The first reaction is depression. There is no reason for giving a transfusion with a normal red blood cell count. When the physician insists we insist that it be small. If you do a count soon after a transfusion you are struck by the fact that you have a depression of bone marrow.

X-ray therapy has been advocated. Almost all the men acquainted with the effect of X-rays say that even in small doses you get depression; and the men who believe there is some stimulating effect admit that it is not necessarily specific and is slow in appearing. The effect of X-ray treatment, when effective, takes four or five days. If the patients are going to get better in that time they will get well spontaneously. In two of Taussig's cases a temporary appearance of granulocytes was obtained after X-ray, but a permanent depression immediately afterwards.

Finally, I wish to discuss the so-called specific remedies for agranulocytosis, pentnucleotide and adenine sulphate. I do not believe that they have been demonstrated to be specific.

Until we can rule out spontaneous recovery, we have no right to claim specific treatment.

Pentnucleotide used by Jackson is easily administered, but occasionally gives constitutional reactions. Adenine sulphate which we use is not as easily administered, but gives no reactions. We dissolve one gram of adenine sulphate in 35 cc. of saline by boiling and give it intravenously, in a fairly warm state to prevent precipitation, every eight hours for at least ten doses. I do not believe that these substances are effective in infectious leukopenia.

New York Hospital and the Department of Medicine,
Cornell University Medical College.

THE AMERICAN BOARD OF OTOLARYNGOLOGY.

An examination was held in Boston, Mass., Sept. 16, 1933, during the meeting of the American Academy of Ophthalmology and Otolaryngology. Seventy-nine candidates were examined, of which thirteen were conditioned or failed.

The Board will hold an examination in Cleveland, Ohio, June 11, 1934, during the meeting of the American Medical Association. Also early in the summer (date is not set) an examination will be held in Butte, Mon., in connection with the meeting of the Pacific Coast Oto-Ophthalmological Society. Prospective applicants for certificate should address the Secretary, Dr. W. P. Wherry, 1500 Medical Arts building, Omaha, Neb., for proper application blanks.

SINUSITIS IN CHILDREN.*

DR. ROMEO LUONGO, Philadelphia.

Sinusitis usually occurs in children between the fourth and ninth year of age, and its frequency is the same as in adults. This does not exclude the possibility of the sinuses becoming infected early in life.

Davis has reported a case of maxillary sinusitis in a child, age 15 days, where the infection was so violent that the anterior wall of the sinus was perforated in three days and the little patient died of pyemia.[3]

The ethmoid labyrinth is well developed at birth; the maxillary sinus, although not completely developed, assumes clinical importance from the first days of life; the sphenoid does not reach its complete development until the twelfth year, but it may get infected about the third year of life and the frontal sinus assumes the aspect of a cavity at the twelfth year, but it may get infected at any time. (Killian operated on a frontal sinus in a child, age 15 months.)

ETIOLOGY.

Predisposing Factors: Diminished organic resistance, vitamin deficiency, allergic conditions, endocrine dyscrasia, lack of sunshine; poor climatic conditions, poor hygiene, humidity, swimming, sudden changes in temperature.

Local Factors: Anything that interferes with the drainage and the areation of the sinuses, as edema of the mucosa, hypertrophy of the middle turbinates, septal deviations, atresia of the nares and choanae, foreign bodies, obstructive tumors, hypertrophied tonsils and adenoids.

Constitutional Factors: Frequent head colds, tonsillitis, measles, scarlet fever, whooping cough, influenza, pneumonia and diphtheria.

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*Abstracted from the thesis presented to the University of Pennsylvania for the degree of "Master of Medical Science in Otolaryngology."

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PHYSIOLOGY AND PATHOLOGY.

The physiology of the sinuses is unknown. We know that they are covered with contractile cilia which have an undulatory movement towards the ostia and that the mucosa is rich in glands which produce abundant secretions.[1]

Anything that interferes with the physiologic movement of the cilia produces stagnation of the secretions which furnish an ideal media for the growth of bacteria. When the infection is well established, pathological changes will occur in the mucosa.[7]

Bacteriology: The following are the bacteria usually found: Pneumococcus, B. Friedländer, Staphylococcus, Streptococcus, B. Aurus, B. diphtheria, Micrococcus Catarrhalis, B. mucosa-capsulatus. The most commonly found are streptococcus and staphylococcus.

Symptoms: Repeated and persistent cold; sneezing, headaches (rare in children); lacrimation; injected conjunctiva; swelling of the eyelids; nasal voice; nasal and postnasal discharge, redness and swelling of the regions of the sinuses.

Diagnosis: Take a diligent history. Investigate for the family tendencies, the contagious factors, allergy and endocrine disturbances.

The usual complaint is of nasal discharge and stuffiness of the nose; find out the duration, the quantity and the nature of the discharge (watery? yellow? green?). There is one physical sign that never fails: a red granular posterior pharyngeal wall covered with an apron of pus or mucopus means sinusitis. Excoriations and irritations of the upper lip and nasal vestibules may mean sinusitis.

In hyperplastic sinusitis there may not be any secretions.

In suppurative cases the mucosa is red, while in allergic cases it is pale and boggy. The transillumination is not of much help in children. The X-rays offer the most reliable means of diagnosis. It is well to bear in mind that the deciduous teeth throw dense shadows on the floors of the antra.

It is necessary to study the cytology and bacteriology of the nasal secretions.[4]

In infections of the antra, the irrigation offers the most reliable source of information. The nature of the pus and the bacteriology and cytology of the antral secretions are carefully studied.

The best method for obtaining the material for culture directly from the antrum is the following: through a sterile needle, inserted into the antrum, introduce (by means of a Lüer syringe) about 3 cc. of sterile normal saline solution and withdraw it for the culture and for the cytological studies of the precipitate.

Nasal polypi are rare in children; they may be present in asthmatic conditions. A complete blood count is necessary for the study of the case.

Prophylaxis: Balance the diet; push Vitamins A and B by giving plenty of butter, fats, orange juice, tomato juice, carrots, fresh fruits, greens and lettuce. Give cod liver oil in small doses. Fresh air and sunshine.

Infrared and ultraviolet rays are very beneficial.

Children who are able to play outdoors are not so susceptible to sinusitis.

Dean believes that hypertrophic tonsils and adenoids are responsible for 80 per cent of the sinus infections.[6]

Vaccine prophylaxis is good. The autogenous vaccine is the best. Stock mixed catarrhal vaccines may also be used.

Allergy and endocrine dyscrasia should be considered in the prophylaxis of sinusitis.

Treatment: The primary causes of sinusitis are three: *1.* Diet deficient in Vitamins A and B. *2.* Hypertrophied tonsils and (especially) adenoids. *3.* Anything that interferes with the drainage and the ventilation of the sinuses.

Therefore in the treatment (as well as in the prophylaxis) of sinusitis these three cardinal points should always be kept in mind.

Every cold is a potential factor in the establishing of infections into the sinuses; therefore, colds should be treated with the greatest concern, and with these possibilities in mind.

In every case of sinusitis hypertrophic tonsils and adenoids should be removed; many cases will be cured with this procedure alone (80 per cent).[5]

Any nasal obstruction, such as foreign bodies, hypertrophic turbinates, septal deflections, spurs and ridges, should be corrected.

Acute rhinitis and acute sinusitis are treated the same way. Keep the patient in bed, in a room that is warm but well

aerated. Stimulate the elimination, give purgatives, alkalinize the patient, correct the diet and force fluids. When the nasal secretions are thick, tenacious and abundant, plugging the nasal fossae so that the nasal breathing is impossible, suckling infants cannot take their feedings and the older children are very uncomfortable. The best way to get rid of these secretions is by aspirating them through a fenestrated catheter.

To shrink the nasal mucosa use aqueous solutions of ephedrine sulphate (1 to 3 per cent) or cocaine hydrochloride (1 to 3 per cent) applied by means of small pledgets of cotton saturated with the solution and applied in the desired areas after the excess of the solution has been squeezed out.

I have never observed any ill effects from the application of cocaine in any child of any age.

For home use order aqueous solution of ephedrine sulphate in different strengths and instruct the parents to use three to five drops in each nostril while the little patient is lying down with a pillow under the shoulders and the head fully extended.

About ten minutes after the instillation of ephedrine (when good shrinkage is obtained) use three to five drops of a 10 per cent solution of argyrol in the same fashion described above.

If the secretions have a tendency to dry up and form crusts, prescribe Camphor-Menthol, $\overline{aa}$ gr. $\dot{T}$ 1, Liq. Albolene, ounces 1. M. et Sig. Five drops in each nostril every three hours.

Applications of infrared and ultraviolet rays are very beneficial. Apply them to the facial region as well as to the entire body. Order cod liver oil or Haliver oil in small doses, and plenty of orange and tomato juices.

Chronic Rhinitis: A chronic rhinitis is not a rhinitis any more, but it is the beginning of sinusitis and it is treated as such.

Subacute and Chronic Ethmoiditis: Make sure that the drainage and the aeration are perfect.

Shrink and apply argyrol or mentholated oils. Alkalinize the patient and stimulate elimination. Correct the diet. Give small doses of cod liver oil or Haliver oil. Give plenty of tomato juice and orange juice to drink. Improve the hygienic

conditions. Give plenty of sunshine and open air. The seashore is advisable.

Apply infrared and ultraviolet rays.

Take care of the general condition with tonics (iron and arsenic orally or hypodermically are excellent).

Vaccine therapy is to be tried in every case. Autogenous vaccines are the best. Stock vaccines (mixed catarrhal) have given good results.

Vaccines should be given very cautiously. Start with very small doses (cc. 0.1) and increase very gradually (cc. 0.1 every third day until cc. 1 is given).

If there are severe reactions give less and at longer intervals. Give it intramuscularly and change the region each time so that the local reactions will not interfere with the absorption.

If the turbinates are enlarged, remove part of them to get good aeration and drainage, but not any more than necessary.

Never use a cautery in a child's nose, because it may interfere with the development of the part.

If a radical operation is indicated (orbital abscesses, septicemiae, pyemiae, meningitis) use the external route; the endonasal route is dangerous and unsatisfactory.

Maxillary Sinusitis: Apply the three fundamental rules: proper diet, proper aeration and ventilation of the sinuses and removal of hypertrophic tonsils and adenoids.

The irrigation offers the best means for diagnosing and treating maxillary sinusitis. It can be done in a child of any age, but X-rays should be taken in each case to determine the meatus of approach. If the floor of the antrum is above the attachment of the inferior turbinate, use the middle meatus, and if it is below, use the inferior meatus.

I use a Wassermann needle slightly longer than usual and of medium caliber. Normal saline is used.

During the irrigation note the amount of force required to push the liquid through; if it requires a moderate amount of force it means partial obstruction at the ostium, and if it requires a considerable amount of force it means almost complete obstruction. If the solution will not go through it means either complete obstruction of the ostium or a polyp that acts

like a ball-valve. In case of partial or complete obstruction it is necessary to remove the cause or to practice a window operation under the inferior turbinate. This is done with clean cutting instruments; rasping will cause early formation of adhesion and of bands of fibrous tissues which will obturate the opening in a short time.

Before the sinus is irrigated, take a specimen for bacteriological and cytological studies. The solution of return should be carefully studied for the presence of pus.

Notice the color, odor, quality, quantity and consistency of the pus. If the pus is green, in gobs that float on the surface, and it does not dissolve in the solution, it means that the infection is acute or subacute; in chronic conditions the pus is fetid, yellowish or brownish and it dissolves into the solution or it precipitates to the bottom.

Turbid solutions are just as significant as the ones containing free pus; when the return solution is not clear, study the precipitates: If the polymorphonuclear leukocytes are found, it means that it is a recent active infection; if mononuclear leukocytes are found, it means that a chronic low-grade infection is present; if eosinophiles are found, it means asthma.

Examine the upper molars and premolars for apical abscesses.

The radical operation on the antrum is very rarely indicated in children.

In the surgery of the antrum it is well to keep in mind the presence of the deciduous teeth. An injury to a tooth germ will cause its death.

Sphenoiditis: Only after the third year of life this sinus can be infected. Up to the twelfth year the sphenoid is part of the ethmoid and therefore any infection is to be treated primarily as an ethmoiditis.

The irrigation of the sphenoid through its ostium by means of a cannula is used for diagnosis and treatment. Through the cannula a specimen can be obtained from the sphenoid for bacteriological and cytological studies in the same manner in which it is obtained from the antrum.

Occasionally the middle turbinate has to be removed in order to gain access to the sphenoid. The anterior wall is rarely removed.

Frontal Sinusitis: Children rarely have any trouble with the frontal sinus before the twelfth year of age. Up to this age the frontal sinus can be considered as part of the ethmoid; therefore, when infected, it is treated as an ethmoiditis.

It is well to remember, though, that Killian has operated on a frontal sinus in a child, age 15 months.

The Proetz displacement method has been useful in cases of ethmoiditis and pansinusitis. It also helps considerably for diagnostic work.

Complications and Sequelae: Sinus infections have great influence on the course and the end-results of the following conditions: acute and chronic pharyngitis; cervical and submaxillary adenitis; frequent colds; recurrent epistaxis; otitis media; conjunctivitis; orbital abscess and cellulitis; optic neuritis; persistent coughs; acute and chronic bronchitis; bronchiectasis; peribronchial thickenings; pulmonary nontubercular infiltrations; anemia; anorexia; malnutrition; cyclic vomiting; chronic digestive disorders; cholera infantum; asthma; myocarditis; cardiac failures; rheumatic fever; arthritis cryptogenetic fevers; nephritis; pyelitis; encephalitis; cavernous sinus thrombosis; brain abscess.[2, 3]

Many cases diagnosed as pulmonary tuberculosis have been cured by curing the sinuses. Marriott and Dean have reported eleven cases of encephalitis which promptly got well when the sinuses were cured.[6] The family physician and the otolaryngologist should cooperate in the treatment of the above mentioned conditions if the sinuses are found to be infected.

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AN OVERLOOKED FACTOR IN SUSCEPTIBILITY TO THE COMMON COLD.

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There is probably no more formidable enemy to human health and comfort than the common cold, the widespread incidence of which continues to defy both etiologic explanation and prophylactic control. This ubiquitous malady not only inflicts upon this country a direct economic loss of four hundred and fifty million dollars annually,* but paves the way to a host of refractory catarrhal difficulties that impose a further sacrifice of occupational efficiency and an ever increasing need for the largest group of specialists in the entire field of medical practice.

Recent efforts to curb the ravages of this universal plague have been focused upon the possible identification of a specific causative agency, the assumption being that prospective laboratory findings offer about the only hope of success. There has been no definite proof, however, that a distinct bacterial cause exists, and even if one were ultimately isolated it is questionable whether the perplexities of the problem would be materially lessened. It is rather difficult to visualize serological protection against a disease which itself tends to augment, rather than diminish, subsequent susceptibility. More readily conceivable are the altruistic possibilities that might accrue from the detection of an eliminable anatomic factor in man's vulnerability to catarrhal infections. Theoretically, a structural abnormality could induce lowered resistance to organisms normally present in the nose and throat and, if common to a great many individuals, might more logically explain the prevalence of "colds" than the supposed aggressiveness and specificity of an undiscovered bacterium or virus. Such an hypothesis is quite consistent with the negative results of bacteriological investigation and is by no means a vain conjecture. It is actually true that clinical research has overlooked one correctible somatic impairment whose predispos-

*Based upon statistics of the U. S. Public Health Service.

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ing influence is empirically and convincingly demonstrable, and whose delayed recognition seems measurably responsible for the erstwhile futility of the fight against the common cold.

This overlooked factor is none other than that apparently innocuous structure, the uvula, so often carelessly designated as "the palate" by both the laity and the profession. This devitalized and physiologically superfluous appendage has never received any critical consideration beyond that accorded it by Hippocrates, who recognized its frequent elongation as a mechanical cause of paroxysmal coughs and advocated staphylotomy as a corrective measure. Unfortunately, Hippocrates' suggestion has never attained great popularity. Had its practical utility in dealing with innumerable cases of convulsive coughing and incessant clearing of the throat been properly appreciated, a vastly more important potentiality of this procedure would inevitably have come to light long before the twentieth century. The main impediment to this revelation has been, and still is, a superstitious and erroneous conception of the functional importance of the uvula, in consequence of which staphylotomy has been inadequately performed even when "cautiously" resorted to.

A customary degree of hesitancy and conservatism dominated the writer's early employment of staphylotomy, but it soon became apparent that a bolder procedure involved none of the dreaded risks and was much more efficacious and dependable. Gradually this was found to be true up to the point of removing the uvula in its entirety, an operation which has since been performed many hundreds of times, and with results as unprecedented as the operation itself. Routine use of "staphylectomy" for the relief of habitual clearing of the throat and an amenable type of paroxysmal cough eventually revealed the rather amazing fact that it also exercised a remedial influence upon catarrhal conditions of the entire upper respiratory tract. Primarily, this was not an objective disclosure, nor was it even a suspected possibility. It was purely accidental. The original observations must be accredited to patients themselves, who repeatedly called attention to various unanticipated benefits conferred by staphylectomy, notably a relative freedom from "colds," but whose alleged experiences were at first regarded as sheer products of the imagination. Except for the repetition and enthusiasm of these incredible contentions, they might not have aroused the

slightest interest, for there seemed to be, at that time, no logical reason to suppose that the mere removal of a small piece of redundant tissue from the faucial arch could produce the remote and phenomenal effects which these patients were wont to ascribe to it. About twenty years have now elapsed since a skeptical investigation of this apparent myth was thus inaugurated, and the unique experience to which it led has afforded incontestable proof of the provocative role of the uvula in uncontrollable recurrences of the common cold and in the intractability of other catarrhal difficulties involving both the nose and throat.

By painstaking follow-up methods and the helpful cooperation of interested patients, it has been determined that staphylectomy checks susceptibility to "colds" in excess of fifty per cent. In occasional instances a complete absence of recurrences has been reported for periods of several years, and rarely have indifferent results been observed. Exact percentages of efficiency can not be tabulated, the controls in this investigation having necessarily been in each case the past experiences of the subject himself. Patients are seldom able to state accurately the number of attacks per year they have previously encountered, but they can make postoperative comparisons that are sufficiently definite for practical purposes, and the contrast is usually so sharp that a precise ratio becomes relatively unimportant. What applies to the comparative frequency of "colds" before and after staphylectomy is equally true concerning the abated intensity and duration of infections that may develop after the uvula has been removed. A peculiar phase of the latter observation is the mildness or entire absence of sinusitis in cases where this had invariably been a troublesome accompaniment or sequel of rhinitis prior to operation.

The effectiveness of complete removal of the uvula has been substantiated not merely through subjective information, but by significant and unmistakable changes in both pharyngeal and nasal structures. The most conspicuous of these visible effects are so prompt and decided in some instances as to literally defy belief. Chronic postnasal engorgement is reduced to a degree that definitely facilitates nasal breathing, and the characteristic signs and symptoms of pharyngeal and nasopharyngeal catarrh are rendered permanently less pronounced. These clearly discernible effects are more than sug-

gestive of a contributory culpability of the uvula in marked catarrhal tendencies; in fact, they have been so constantly observed as to admit of no other interpretation.

The part played by the uvula in predisposition to the common cold and kindred affections may not appear so strange and inexplicable if we take into consideration the extremely poor vascularity of this structure and its other correspondingly sparse histologic components, which would unavoidably render it less resistant than the substantial and well vascularized portions of the pharynx. Furthermore, its anatomical location is especially favorable to the accumulation of ceaseless installments of bacteria, dangling directly in the pathway of both respiration and deglutition. It is thereby subjected also to more or less mechanical abuse, particularly in the act of snoring. These combined characteristics make the uvula an ideal bacterial nidus upon which microorganisms gain a flourishing foothold, subsequently invading in overpowering numbers the posterior nares and other contiguous areas that might otherwise be capable of maintaining a relatively healthy status. (In striking conformity with these practical considerations is the well-known fact that the earliest symptom of an incipient coryza is not referable to the nose, but is almost invariably a sensation of dryness and pruritic discomfort in the vicinity of the soft palate, nasal involvement being a somewhat delayed development.)

This line of reasoning may appear fundamentally defective in that it wholly ignores the supposed functional requisites of the uvula. But does the uvula really serve any distinct or valuable purpose in the human being, or is it a superfluous and rudimentary structure? In lower animals it is essential to a reflex expulsive mechanism of vital importance. During the act of panting it thus affords protection against the hazardous ingress of flying insects and other foreign material, but aside from its participation in this highly necessary defense of the larynx and pulmonary tract, it serves no other purpose for which the major portion of the normal velum palatinum does not alone suffice. The life and habits of primitive man undoubtedly demanded similar protection, but it has been a long, long time since man ran through the wilds, panting. Since civilization abolished this need of the mouth as an accessory avenue of breathing, the uvula has had virtually no function to perform and protracted disuse has rele-

gated it to the category of obsolete and decadent structures. As in the case of the appendix vermiformis, cessation of function has impaired its blood supply, decreased its size and substance, lowered its vitality in general and transformed it into a mere rudiment and an insiduous pathogenetic factor. Its pathological influence upon adjacent structures might be likened to that of an extraneous growth similarly situated, as there is a direct parallel in the observed effects of excision. Corroborative evidence of this supposed evolutionary and diminutive change in the physical characteristics of the uvula is afforded by a comparison of this almost cylindrical remnant as it now exists in the human being, with the substantial, broad, triangular curtain suspended in the throat of the lower animal. Scores of dried specimens in the writer's possession bear convincing testimony to this advanced degenerative transition.

Within the past year an interesting counterpart of this hypothesis appeared in the editorial columns of a metropolitan newspaper under the heading: "Colds and Evolution." Although written in the abstract, and with no implied reference to the uvula, this article presented a truly prophetic assumption that justifies its quotation, in part, as follows:

"There has been taking place almost insensibly in biological science, these last decades, a change of emphasis not well appreciated even by the biologists. The theory of evolution no longer is regarded as something to be proved. This has been done. Instead, the essentials of the theory now may be accepted as guiding principles in explaining other facts still unclear or in exploring other circumstances still unknown. If the anatomist finds, for example, some bodily organ or structure apparently useless to its modern possessor, it is legitimate for him to assume that this organ once was necessary and that some change in the habits or circumstances of the species has lessened its utility. The familiar example is the human appendix. *The same principle should apply to this mystery of colds.* It is impossible to accuse Nature of deliberately aiding the invasion of men's throats or noses by harmful germs."

The author of this article probably did not actually foresee an early substantiation of his theoretical surmise, but it is nevertheless true that the uvula is the evolutionary agency involved and that its general recognition as such will render this "mystery of colds" far less enigmatical.

There is no preoperative means of gauging the pathogenic culpability of the uvula in cases of marked susceptibility to the common cold. Neither its size nor any other observable characteristic affords a dependable index to the advisability of excision, for it has been found that an exceptionally small uvula may be a source of pronounced disturbance and that it is not the elongated type only that definitely contributes to lowered nose and throat resistance. Staphylectomy may therefore be considered a justifiable and advantageous procedure in practically all cases exhibiting aggravated catarrhal tendencies, its efficacy being determined by the thoroughness of the operation and not by the dimensions nor the consistency of the tissue removed.

Denunciation of this radical proposal may be dictated by popular prejudice, but a practical and reliable estimate of its alleged rationality and merits is readily available to every member of the profession. The means is extremely simple and clinical material everywhere abundant.

Staphylectomy is such a minor procedure that it hardly admits of a technical description. It exacts no unusual skill of the operator nor does it demand special facilities. The topical employment of Cocaine, or Larocaine (Roche), in sufficiently generous amounts renders the operation practically painless. The use of both hands being essential, it becomes necessary for the patient to manipulate the tongue-depressor, which he or she can be instructed to do even more expeditiously than a trained assistant. Active hemostatic measures have never been required, although the possibility of their need has at times been anticipated. Only a trivial amount of bleeding is ordinarily witnessed and spontaneous arrest usually takes place in from one to five minutes. In many instances there is practically no hemorrhage at all. Postoperative care is a negligible consideration, but patients have, when practicable, been kept under daily observation until the wound was fully healed. The importance of removing the uvula in toto can not be too strongly emphasized, as no compromise between staphylotomy and *staphylectomy* will yield results clearly confirmatory of the original findings reported.

Superstitious aversion to complete removal of the uvula has for ages obscured the possibility of an epochal rhinolaryngological achievement, for only through the experimental em-

ployment of staphylectomy would it be possible to glean the facts that are indispensable to success in the long attempted conquest of "colds" and related nose and throat disturbances. This obstructive prejudice, although universal, is entirely unwarrantable. Over two thousand staphylectomies have revealed not the slightest justification for it. In the hands of the writer the procedure in question long ago passed from the stage of experimentation to that of established clinical utility, the enormous scope of which will prove no less astounding to future investigators than it has in the course of this anomalous experience.

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